This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

G

ANNUAL REPORT OF THE CHIEF OF ENGINEERS, 1915

APPENDIX

A HISTORICAL SUMMARY GIVING THE SCOPE OF PREVIOUS PROJECTS FOR THE IMPROVEMENT OF CERTAIN RIVERS AND HARBORS.

WASHINGTON
GOVERNMENT PRINTING OFFICE
1915

Digitized by Google

Eng 1019.15.11

HARVARD COLLEGE
LIBRARY

TRANSFERRED FROM THE
BUREAU FOR RESEARCH
IN
MUNICIPAL GOVERNMENT

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

d/ H.C.Rpt

O

A HISTORICAL SUMMARY GIVING THE SCOPE OF PREVIOUS PROJECTS FOR THE IMPROVEMENT OF CERTAIN RIVERS AND HARBORS.

WASHINGTON
GOVERNMENT PRINTING OFFICE
1915

Digitized by Google

Eng 1019.15.11

✓

HARVARD COLLEGE LIBRARY
RECEIVED THROUGH THE
BUREAU FOR RESEARCH IN
MUNICIPAL GOVERNMENT
1936.

Digitized by Google

APPENDIX

TO THE

ANNUAL REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY,

FOR THE FISCAL YEAR ENDING JUNE 30, 1915,

BEING

A HISTORICAL SUMMARY GIVING THE SCOPE OF PREVIOUS PROJECTS FOR THE IMPROVEMENT OF CERTAIN RIVERS AND HARBORS.

8373°—ENG 1915——109

Digitized by Google

Digitized by Google

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE PORTLAND, ME., DISTRICT.

1. ST. CROIX RIVER, ME.

About 1856 three piers were built at the ledge 3.5 miles below Calais by the Lighthouse Establishment to prevent vessels descending the river on ebb tide from being thrown on the ledge.

The river and harbor act of June 23, 1866, directed an examination at St. Croix River above the ledge, and the river and harbor act of March 2, 1867, made an appropriation of $15,000, with the proviso that "The Province of New Brunswick shall contribute and pay to the proper disbursing officer a like sum for said purpose, said payment being made on condition that in no event shall the Province of New Brunswick be called upon for more than half the sum actually expended for said purpose." The annual report for 1867 contained an estimate of $88,000 as the cost of a channel 100 feet wide and 10 feet deep at low water. In 1868 the estimate was increased to $99,000, and in 1871 to $100,000. The river and harbor act of March 3, 1873, carried an appropriation of $10,000 and the river and harbor act of June 23, 1874, an additional $10,000, making a total of $35,000. The Dominion of Canada made an appropriation of $25,000. In the annual report for 1875 a project for a channel 9 feet deep at mean low water, 200 feet wide up to Todds Ledge, and 100 feet wide thence to the toll bridge, was estimated to cost $200,000. In 1874 the minister of public works of the Dominion of Canada refused his consent to the expenditure of Canadian funds until satisfied that there would be no further deposits of mill waste to again close the channel. In 1877 the estimated cost of the project was put at $150,000. The river and harbor act of March 3, 1879, made the unexpended balance, amounting to $34,000, available for another locality (Lubec Channel).

A resolution of the House of Representatives, December 15, 1880, requested information as to the condition of the breakwater (piers), the necessity for repair, and the probable cost. The report (H. Ex. Doc. No. 27, 46th Cong., 3d sess.) represented the piers as in bad condition and submitted an estimate of $4,000 as the cost of rebuilding them. The river and harbor act of March 3, 1881, appropriated $4,000, and the work was accomplished the same year.

Under the provisions of the river and harbor act of August 11, 1888, a new survey was made, and the report (H. Ex. Doc. No. 89, 51st Cong., 1st sess.) submitted a project for a channel 12 feet deep at mean low water, generally 200 feet wide, but narrowed to 150 feet and 100 feet in the upper part, estimated to cost $280,000. The river and harbor act of September 19, 1890, made an appropriation of $35,000, "but upon the condition that the Government of the Dominion of Canada shall expend a like sum in the improvement of

Digitized by Google

said river." No work was done, and under authority contained in the river and harbor act of August 18, 1894, the unexpended funds, $35,000, were applied to the work of improving Lubec Channel, Me.

5. CARVERS HARBOR, VINALHAVEN, ME.

Previous improvement at this locality was based on a report on a survey (H. Ex. Doc. No. 304, 53d Cong., 3d sess.), which contained a project which was adopted by the river and harbor act of June 3, 1896. It consisted in dredging an area of about 23 acres, representing the greater portion of the main part of the harbor, to the depth of 16 feet at mean low tide. The estimated cost was $64,000. Appropriations aggregated $45,000. The improvement was completed in 1903. The total cost was $43,199.70.

6. PENOBSCOT RIVER, ME.

The river and harbor act of June 23, 1866, directed an examination of the Penobscot River above Hampden, Me. The report (Annual Report for 1868, p. 863) contained a project for a channel 150 feet wide and 12 feet deep at low water at Bangor and for a distance of about 3.5 miles below. The work involved the removal of mill waste and ledge and was estimated to cost $125,000. The first appropriation was $15,000 by the river and harbor act of July 11, 1870. In the Annual Report for 1871 the channel width was increased to 200 feet and the estimated cost to $155,000. The river and harbor act of March 3, 1875, which carried an appropriation of $25,000 for work under this project, contained a proviso that $10,000 of said sum should be expended at or near Bucksport Narrows (18 miles below Bangor). Under this authority the middle ground in front of the wharves at Bucksport was dredged in the same year to 12 feet at mean low water. The Annual Report for 1876 included some additional ledge excavation at Bangor and raised the estimated total cost to $172,000, exclusive of the Bucksport work. The river and harbor act of August 14, 1876, made an appropriation of $10,000, and directed that $4,000 of said sum should be expended at Bucksport. This sum was applied to further dredging on the middle ground, but to the depth of 8 feet at mean low water, in 1877. The river and harbor act of June 18, 1878, again provided for work at Bucksport by making $2,500 of the Penobscot appropriation available for work at that place. Under this authority additional dredging was done in October, 1878. By the close of the fiscal year 1880 all the work projected for Penobscot River had been completed. Appropriations aggregated $198,300, which included $300 for survey appropriated March 2, 1829, and $16.500 expended at Bucksport.

The river and harbor act of August 2, 1882, directed a preliminary examination of Penobscot River and Bangor Harbor. A survey followed (S. Ex. Doc. No. 44, 48th Cong., 1st sess.). The resulting project, which was adopted by the river and harbor act of July 5, 1884, provided for widening the channel at Bangor 100 feet for a length of about 4,500 feet to the depth of 11 feet at extreme low water (or 14 feet at mean low water), and to widen the channel near Crosbys Narrows so as to give a width of not less than 250 feet and a

Digitized by Google

depth of 12 feet at extreme low water. The estimated cost of this project was $75,000. The river and harbor act of August 5, 1886, directed a preliminary examination of Penobscot River from Bangor to Bucksport Narrows. The survey report (H. Ex. Doc. No. 133, 50th Cong., 1st sess.) suggested a project for a channel depth of 22 feet at mean low water and a width of not less than 400 feet between Winterport and Bucksport, a distance of about 6 miles. The project included the construction of five jetties, ranging in length from 920 to 2,650 feet and for dredging about 500,000 cubic yards of sawmill waste. The estimated cost was $365,000, making the estimate for the combined project $440,000. This addition to the project was adopted by the river and harbor act of August 11, 1888, subject to approval by the Secretary of War. The river and harbor act of September 19, 1890, directed another examination of Penobscot River. A survey was made (H. Ex. Doc. No. 37, 52d Cong., 1st sess.) and a project submitted for a further widening of 60 feet at Bangor, for the construction of two jetties near Crosbys Narrows and three jetties between Winterport and Bucksport, at a total estimated cost of $202,000. The river and harbor act of July 13, 1892, made an appropriation of $40,000.

The project for Penobscot River had now become somewhat complicated, and in 1893 it was simplified as follows: To widen the channel at Bangor to 360 feet and a depth of 11 feet at extreme low water, to widen and straighten and deepen the channel near Crosbys Narrows and near Sterns Mill to a depth of 12 feet at extreme low tide, and to secure a channel depth of 22 feet at mean low tide between Winterport and Bucksport. The estimated cost of the entire work was placed at $440,000, of which $150,000 had up to that time been appropriated. As the channel between Winterport and Bucksport appeared to be deepening from natural causes, the expensive jetties were not to be built until proven necessary. By the close of the fiscal year 1895 the object of the project had been secured. The jetties were not built. The appropriations to that date aggregated $348,300 and the total expenditures had been $337,761.57.

The river and harbor act of June 3, 1896, directed a survey of Bangor Harbor and Penobscot River, including mouth of Kenduskeag River. The report (H. Doc. No. 49, 55th Cong., 1st sess.) contained a project for dredging a channel 90 feet wide and 2 feet deep at extreme low tide in Kenduskeag River from its mouth up to Kenduskeag Bridge, a distance of about 2,300 feet, and for deepening the harbor of Bangor in front of the Boston and Bangor steamboat wharf to 11 feet at extreme low tide, from the harbor line out, involving the removal of ledge. The estimated cost was $28,620.90. This project was adopted by the river and harbor act of March 3, 1899, which appropriated $28,000 for completing the improvement. The work was completed in 1901.

8. ROCKPORT HARBOR, ME.

The river and harbor act of August 5, 1886, ordered an examination of Rockport Harbor. A survey resulted and the report (H. Ex. Doc. No. 141, 50th Cong., 1st sess.) contained a project for dredging an area about 400 feet by 600 feet in front of the wharves at the

Digitized by Google

head of the harbor to the depth of 12 feet at mean low tide and for removal of a small ledge. The estimated cost was $14,000. The project was adopted by the river and harbor act of August 11, 1888. The work was completed in August, 1891. The total cost was $15,000.

12. SASANOA RIVER, ME.

The river and harbor act of March 2, 1867, directed an examination of this locality under the title "Gut opposite the city of Bath, Maine." A survey was made, the report on which submitted a project (Annual Report for 1867, p. 499) for removing a point of ledge which obstructed the channel at Upper Hell Gate, about 2 miles east of Bath; for removing Boiler Rock, about 75 yards below Upper Hell Gate, to 12 feet at mean low tide; and for dredging a channel 100 feet wide and 10 feet deep at mean low tide, through the bar about midway between Upper Hell Gate and Arrowsic Bridge. The estimated cost was $16,500. This project was adopted by the river and harbor act of July 11, 1870. By the close of the fiscal year 1873 the project was completed. The work consisted in ledge excavation at Upper Hell Gate so as to give a low-water width of 150 feet, formerly 100 feet; the removal of Boiler Rock to 10 feet at mean low tide, and the removal to a depth of 9 feet at mean low tide of a ledge extending from Boiler Rock northward toward the shore; the removal of two wrecks lying mid-channel near Upper Hell Gate; and the dredging of a channel 100 feet wide and 10 feet deep at mean low tide, through the bar above Upper Hell Gate. The total cost was $16,500.

February 21, 1878, a special report (Annual Report for 1878, p. 197) as to necessity for further improvement was submitted in response to a resolution of the House of Representatives of February 13, 1878. The project suggested covered the dredging of the shoal above Upper Hell Gate to 12 feet at mean low tide, the widening of the passage through Upper Hell Gate, and the removal of a small quantity of ledge north and east of Marsh Island. The estimate was $17,000. The project was adopted by the river and harbor act of June 18, 1878, which appropriated the entire estimated cost. In the Annual Report for 1879 additional ledge excavation at Marsh Island and the construction of a jetty were added to the project and the estimated cost was increased to $35,000. The project was completed in September, 1882, at a cost of $29,000, the sum of the appropriations.

Another survey was made under the provisions of the river and harbor act of August 17, 1894. The project (H. Ex. Doc. No. 142, 53d Cong., 3d sess.) which was estimated to cost $19,000, provided for dredging to 12 feet at mean low tide over the shoal at Carletons Ledges, a short distance above Upper Hell Gate, to place a beacon on the jetty, and to secure a depth of 12 feet at mean low tide for a width of 125 feet through the ledges at Upper Hell Gate. This project was adopted by the river and harbor act of June 3, 1896, which provided the entire estimated cost. The project was completed during the fiscal year 1898, at a cost of $11,987.69, and the balance carried to the surplus fund.

Digitized by Google

18. KENNEBEC RIVER, ME.

The river and harbor acts of March 2, 1827, May 19, 1828, April 23, 1830, July 3, 1832, and an act of July 20, 1840, carried appropriations aggregating $13,595.71. The acts specified the object to be for removing obstructions at Lovejoys Narrows, a locality in the main river east of the upper end of Swan Island, where ledges formed a dangerous obstruction to navigation.

A report (H. Doc. No. 94, 25th Cong., 2d sess.) submitted September 30, 1837, by Lieut. Col. S. H. Long, Topographical Engineers, submitted a project for improvement from Augusta, at the head of navigation, downstream to Lovejoys Narrows, the purpose being to secure 6 feet at low water from Augusta to Hallowell, 8 feet from Hallowell to Gardiner, and from 8 to 10 feet from Gardiner to Lovejoys Narrows. The estimated cost was $25,000. In 1845 or 1846 the citizens of Augusta expended $9,500 in an attempt to dredge a channel from Augusta to Shepards Point, a short distance below Hallowell. Some benefit is said to have been secured, though the design was not effectually carried out. The river and harbor act of August 30, 1852, appropriated $6,000 for improving the Kennebec River from the United States arsenal wharf in Augusta, Me., to Lovejoys Narrows. The annual report for 1853 contained an estimate of $13,000 to $17,000 as the cost of securing a channel from 7 to 8.5 feet deep at low water and from 70 to 100 feet wide.

The river and harbor act of June 23, 1866, appropriated $20,000 for the improvement of the river between Shepards Point and the city of Augusta, and the same act directed an examination of the river above Gardiner. The project for improvement between Augusta and Shepards Point (Annual Report for 1867) was to secure 7 feet at low water from Augusta to Hallowell and 8 feet from Hallowell to Shepards Point, the width to be 75 feet on the bottom. The estimated cost was $50,000. The river and harbor act of March 2, 1867, appropriated $30,000 for completing the improvement, making $50,000 in all. The survey which followed the examination ordered by the act of 1866 submitted a project (Annual Report for 1868) for a depth of 6.5 feet at low water from Augusta to Hallowell and 7 feet from Hallowell to Gardiner, the width to be 100 feet. The estimated cost was $80,000, or $30,000 in addition to the amount already appropriated for the section between Augusta and Shepards Point. The reduction in depth was due to ledge met above Hallowell. The river and harbor act of March 3, 1871, appropriated $10,000, and contained another item of $5,000 for improvement between Gardiner and Richmond. The Annual Report for 1871 contained a project for a depth of 10 feet at mean low tide and a width of 100 feet, and for the removal of ledge and bowlders between Gardiner and Richmond, at an estimated cost of $13,000. The Annual Report for 1872 contained an additional estimate of $13,500 for removing certain ledges at Lovejoys Narrows to 12 feet at mean low tide. The extent of this work was later increased. All the projected work was completed by 1877. The total appropriations to this time had been $161,445.71.

The river and harbor act of June 14, 1880, directed an examination of Richmond Harbor on the Kennebec River, Me. A survey was

Digitized by Google

made, and the report (H. Doc. No. 29, 46th Cong., 3d sess.) submitted a project for a channel 150 feet wide and from 10 to 11 feet deep at mean low tide west of Swan Island. The work included dredging and the construction of wing dams, at an estimated cost of $20,500. The sum of $20,000 was appropriated in 1881 and 1882. The project was completed in 1883.

The river and harbor act of August 5, 1886, directed an examination of Kennebec River at Bath and from Augusta to lower end of Perkins Island. A survey was made and a project submitted (H. Ex. Doc. No. 133, 50th Cong., 1st sess.) for securing a width of 100 feet and a depth of 8 feet at low water from Augusta to a point midway between Hallowell and Gardiner; a width of 125 feet and depths of 8 feet and 10 feet at low water, thence to Gardiner; for removing ledge at Lovejoys Narrows; for constructing an extensive jetty at Beef Rock Shoal at the foot of Swan Island and three smaller jetties west of Swan Island; and for removing a rock at Bath. The project was estimated to cost $410,500, and was adopted by the river and harbor act of August 11, 1888. The Annual Report for 1891 increased the estimate to $428,500, due to the necessity for dredging at Beef Rock and Hatchs Rock Shoals. In August, 1892, the project was revised, and in the Annual Report for 1893 it is stated as follows: For a channel depth of 13 feet up as far as Sands Island, 12 feet from thence to Hinckley Shoal, and 10 feet from thence to Augusta; a steamboat channel, 9 feet deep, west of Swan Island; and the removal of old bridge piers at Hallowell; all depths being referred to mean low tide. The estimated cost of the project was set at $388,500. This project was essentially completed in 1898. Appropriations amounted to $330,000.

The river and harbor act of March 3, 1899, ordered an examination of Kennebec River between Gardiner Bridge and Augusta Dam, about 6.5 miles. A survey was made and a project submitted (H. Doc. No. 262, 56th Cong., 1st sess.). Some shoaling had occurred, and it was proposed to secure a width of 125 feet to a depth of 11 feet at mean low water, corresponding to 16 feet at mean high water, to remove a small middle ground opposite Farmingdale and a small shoal at the entrance to the draw at Gardiner Bridge. The cost was estimated at $81,000. This project was adopted by the river and harbor act of June 13, 1902, and was placed under the continuing-contract system. The project was completed in 1908.

The appropriations for the foregoing projects aggregated $592,445.71 and the expenditures $590,411.03.

14. PORTLAND HARBOR, ME.

The first work for improvement of Portland Harbor was based upon a survey made in 1832 by Lieut. Col. John Anderson, Topographical Engineers. His report (H. Doc. No. 491, 23d Cong., 1st sess.) suggested two breakwaters—one extending from a point on the south side of the entrance to the inner harbor out to Stamford Ledge at an estimated cost of $44,417.08 and the other extending from the easterly point of the city out on to the middle ground at an estimated cost of $50,435.20. The object of the breakwaters was to protect the wharf front from seas and undertow, and it was also expected that by controlling the tidal flow the tendency to form the

Digitized by Google

shoal known as the middle ground at the entrance to the inner harbor would be reduced.

The river and harbor act of July 4, 1836, authorized the breakwater to Stamford Ledge and made the first appropriation $10,000. The breakwater was constructed extending for a length of about 1,900 feet in a northeasterly direction and nearly parallel to the wharf line on the opposite, or Portland, side of the harbor. By river and harbor act of June 23, 1866, Congress authorized the extension of the breakwater, which was completed to a total length of about 2,000 feet by July 1, 1874.

By joint resolution of June 5, 1868, Congress authorized the unexpended balance of the breakwater appropriation to be expended in excavating the middle ground near said breakwater and in otherwise protecting the channel. The project adopted under this authority was to dredge a channel 300 feet wide and 20 feet deep at mean low tide through the southern slope of the middle ground and to remove the lower end of the bar off the Grand Trunk wharves to the same depth. In 1870 the width of channel through the middle ground was increased to 400 feet and in 1871 to 500 feet. The dredging was completed in July, 1872.

The river and harbor act of June 10, 1872, which appropriated funds for the breakwater, which had not yet been completed, provided "for the improvement of Portland Harbor and Back Bay." The project adopted for Back Cove consisted in dredging a channel 100 feet wide and 8 feet deep at mean low tide, for a distance of about 900 feet up to the stone-shed wharves. This work was accomplished in 1873–74.

In December, 1872, the district officer recommended to the Chief of Engineers that additional dredging be done in the main harbor. After an appropriation of $50,000 made by the river and harbor act of March 3, 1873, dredging to 16 feet at mean low tide along the wharf front of the inner harbor above the middle ground was added to the project. This work, together with some additional dredging in front of the Grand Trunk wharves, was completed in 1875, except for some dredging along the wharf front above Merrill's wharf, which was deferred because several wharves projected beyond the harbor commissioner's line. In 1881, with funds then available, the 16-foot depth along the wharf front was extended a short distance upstream to the lower of the projecting wharves, and an area in front of Atlantic wharf, farther down the harbor, was dredged to 21 feet at mean low tide. In the same year an estimate of $160,000 was made for removing the middle ground to 21 feet below mean low tide. Congress made an appropriation of $20,000 by the river and harbor act of March 3, 1881, and the work was commenced. It was completed in 1885. The total expenditures to June 30, 1885, were $427,929.21. In 1886–87 a small amount of dredging was done in removing shoals in the upper harbor and in extending the 21-foot depth up to Franklin Wharf.

In 1886 a plan was submitted for dredging a channel in Back Cove 300 feet wide and 12 feet deep at mean low tide, for a distance of about 5,600 feet, following the harbor commissioner's line, the estimated cost being $180,000. Congress made the first appropriation August 5, 1886. The work was carried on separately until 1896,

Digitized by Google

when it was combined with the project for Portland Harbor. It was completed in 1899.

In the same year—1886—a project was proposed for a channel 500 feet wide and 29 feet deep at mean low tide, extending about 3,000 feet from the 29-foot contour at the entrance up to the lower wharves. The cost was estimated at $135,000. The river and harbor act of August 5, 1886, appropriated $30,000. In 1890 a small amount of dredging along the wharf front in the upper part of the harbor, to 16 feet at mean low tide, was included with the project. The project was completed in 1893, but in February, 1894, a small extension of the 29-foot area, and a cut about 1,700 feet long, 320 feet wide, and 25 feet deep at mean low tide, connecting the 29-foot channel with deep water in the upper harbor, was added without increase in the estimated cost. This work was completed late in 1894.

By the river and harbor act of June 3, 1896, Congress adopted a project for dredging to 30 feet at mean low tide over the greater part of the inner harbor. This included an area about 9,000 feet long, with a width of about 650 feet at the upper end and about 2,000 feet at the lower end, exclusive of the 29-foot dredging done under the project of 1886. The estimated cost was $770,000. The same act placed the work under the continuing-contract system, and combined with it the unfinished project for Back Cove. The limit of cost was fixed at $830,000. The work in Back Cove was completed in 1899, and that in the main harbor in 1902, at a total cost about $253,000 less than the estimate. The sundry civil act of March 3, 1905, authorized an amendment to the project of 1896, by which the 30-foot channel was to be continued up Fore River about 8,000 feet, as far as the Boston & Maine Railroad bridge, and a channel of the same depth, about 5,400 feet long, leading up to Back Cove, was to be dredged. The width in each case was to be about 300 feet. The act provided that the total cost should not exceed the limit set by the act of June 3, 1896. The amended project was completed in 1908.

15. SACO RIVER, ME.

The river and harbor act of March 2, 1827, appropriated $7,000 for the erection of piers, placing beacons or buoys, and removing obstructions at and near the entrance into the harbor of Saco in the State of Maine. It appears that $5,000 was appropriated for a similar purpose in 1824, so that from 1824 to 1827 the sum of $12,000 was applied to this work. Twelve piers of timber and stone were built, 10 in the river to facilitate navigation by sailing vessels and 2 outside the mouth designed to create a channel through the bar.

The river and harbor act of June 23, 1866, appropriated $40,000 for continuing the repair of the piers. A project was submitted by Lieut. Col. B. S. Alexander, Corps of Engineers, October 16, 1866, suggesting the construction of a breakwater 2,915 feet long on the north side of the mouth of the river and the removal of a small rock. The estimated cost of the breakwater was $192,500. In the annual report for 1867 the estimated cost of the project is put at $270,000. In 1868 the project was described as the construction of a breakwater at the mouth of the river, the removal of sunken rocks, and the rebuilding of some of the most important piers in the river. The annual report for that year suggested an extension of the breakwater

Digitized by Google

about 800 feet and raised the estimated cost of the project to $320,000. The project was completed in 1874, and included the construction of the breakwater for a length of 4,200 feet to a height of 10 feet above mean low water, the removal of sunken rocks from the channel near Little Islands, dredging a channel at Saco and Biddeford to 5 feet at mean low water, placing a spindle to mark the foot of Cow Island Ledge, and building three new piers and repairing one old one. The total cost was $162,271.75.

The river and harbor act of August 2, 1882, ordered a resurvey of the breakwater at the mouth of Saco River. The report (S. Ex. Doc. No. 44, 48th Cong., 1st sess.) recommended the repair of the breakwater and its extension 2,200 feet to Sharps Ledge, the building of a jetty about 3,000 feet long on the south side of the mouth of the river, and dredging a channel 200 feet wide and 5 feet deep at mean low water between the breakwater and jetty. The cost was estimated at $356,500. The river and harbor act of July 5, 1884, appropriated $15,000 for improving breakwater at the mouth of Saco River, Me.: Continuing improvement and repairs. The same act ordered an examination of Saco River. The survey report (H. Ex. Doc. No. 37, 49th Cong., 1st sess.) suggested improvement with the object of securing a channel 6 feet at mean low tide from Saco and Biddeford to the mouth of the river, a distance of about 5 miles. The work was to include dredging, ledge excavation, the construction of two jetties, and the repair and removal of piers, at an estimated cost of $50,000. This project was adopted by the river and harbor act of August 5, 1886, which appropriated $12,500.

The river and harbor act of September 19, 1890, combined the last two projects and made an appropriation of $65,000 for continuing improvement, including breakwater and the construction of a proposed jetty opposite the same.

The river and harbor act of March 3, 1909, ordered another examination of Saco River, as a result of which the existing project, which supersedes all others, was adopted.

The total expenditures under the above projects amounted to $346,680.12. The extension of the breakwater to Sharps Ledge was not undertaken. The other items were practically accomplished. The breakwater was built for a length of about 4,200 feet and the jetty to a length of about 4,200 feet.

16. HARBOR AT ISLES OF SHOALS, ME., AND N. H.

According to local historians the first work at this locality was about the beginning of the nineteenth century, when one Samuel Haley constructed a short wall extending westwardly from Smuttynose Island to Malaga Island. An act approved March 3, 1821, authorizing the building of lighthouses, and for other purposes, requested the President to cause an examination or survey to be made to ascertain the expediency and practicability of repairing the sea wall at Smuttynose Island and of building a sea wall between said island and Cedar Island. The act also authorized the repair of the aforesaid sea wall and appropriated a sum not exceeding $2,500 for that purpose and the building of a stone pier on Sunken Rocks in the harbor of Portsmouth. The lighthouse act of May 7, 1822, authorized the Secretary of the Treasury to provide, by contract, for building a sea

Digitized by Google

wall or pier between Cedar Island and Smuttynose Island, conformably to the report of the commissioners appointed under the provisions of the act of March 3, 1821, and appropriated the sum of $11,500. Local history has it that in 1821 the Government reconstructed and improved the short wall and built the one between Cedar Island and Smuttynose Island. In 1874 it was reported that the latter wall or breakwater had been so battered that very little of it remained above low water.

The river and harbor act of March 3, 1899, directed an examination with a view to building a breakwater from Smuttynose Island to Cedar Island. A survey was made and the report (H. Doc. No. 255, 56th Cong., 1st sess.) proposed to rebuild the breakwater on the old site to a height of about 15 feet above mean low tide. The work was estimated to require 25,000 tons of stone and to cost $30,000. This project was adopted by the river and harbor act of June 13, 1902, which appropriated the entire estimated cost. The work was completed in 1904. It cost $28,201.60.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE BOSTON, MASS., DISTRICT.

---

2. MERRIMAC RIVER, MASS.

The original project was adopted by the act of May 23, 1828, and was for removing the sand bar at or near the mouth of Merrimac River by erecting piers or other works. Under this project $67,466.72 was expended prior to 1850 in removing sand bars and building and repairing a breakwater at the mouth of the river. The river at the mouth was subsequently improved under separate project for "Improving harbor at Newburyport, Mass."

The river and harbor act of July 11, 1870, as extended by the river and harbor act of June 23, 1874, was for improvement of the river above the mouth, excavating a channel, and removing obstructions at upper and lower Mitchells Falls (above Haverhill); removing Gangway and other rocks in Newburyport Harbor and a wreck near the mouth of the river. These projects were completed by June 30, 1894, at an expenditure of $182,000.

The river and harbor act of June 3, 1896, made an appropriation of $5,000 for removing "certain rocks below Rocks Bridge," and the work was completed in the same year at an expenditure of $5,000.

4. GLOUCESTER HARBOR, MASS.

The original project as adopted by the river and harbor act of June 10, 1872, and extended by the river and harbor acts of August 11, 1888, September 19, 1890, and June 3, 1896, was for clearing the inner harbor of obstructing rocks and shoals, dredging the water front from Fort Point to Pews Wharf, a distance of 3,900 feet, to the depth of 15 feet ,and Harbor Cove to the depth of 10 feet at mean low water; completed at an expenditure of $87,681.65.

Digitized by Google

The project adopted by the river and harbor act of August 18, 1894, provided for the construction of a rubblestone breakwater, surmounted by a superstructure of dry walls of heavy split stone inclosing a core of rubblestone, from Eastern Point over Dog Bar to Round Rock Shoal, at an estimated cost of $752,000 (H. Ex. Doc. No. 56, 48th Cong., 2d sess., no map; Annual Report for 1885, p. 534). The river and harbor act of June 13, 1902, authorized the termination of the breakwater at Cat Ledge and the application of any remaining balance "toward the work of removing Round Rock," at a reduced estimate of $416,083.43. Under that authority the breakwater was completed in 1905 as far as Cat Ledge, a length of 2,250 feet, at a cost of $410,097.19. In addition, $16,004.16 was spent for maintenance.

Upon a subsequent examination of Round Rock Shoal it was found that the cost of removing it to the level of the surrounding bottom, exceeding $800,000, was disproportionate to the probable benefits to navigation. The project has been reviewed by the Board of Engineers for Rivers and Harbors, which recommends return to the original project of 1894 for a breakwater from Eastern Point to Round Rock Shoal, and its views are concurred in. The total cost of the extension is estimated at $354,000.

5. BEVERLY HARBOR, MASS.

The original project was adopted by the river and harbor act of June 13, 1902, and was to widen the channel from Monument Bar beacon to a point about 200 feet east of Rams Horn beacon to a width of 200 feet, with a depth of 18 feet at mean low water, at an estimated cost of $10,000 (H. Doc. No. 129, 56th Cong., 2d sess., no map; Annual Report for 1901, p. 1065). This project was completed by 1904, except at three points where ledges restricted the width to 106 feet, at a cost of $8,272.10. These three ledges were removed under the project adopted by the river and harbor act of March 2, 1907.

6. SALEM HARBOR, MASS.

The original project was adopted by the river and harbor act of March 3, 1873, and was to dredge a channel of approach to the mouth of South River, 1,730 feet long, 300 feet wide, and 8 feet deep at mean low water, at an estimated cost of $32,000. The work was essentially completed April 20, 1875, at a cost of $25,000.

The river and harbor act of September 19, 1890, provided for clearing out the channel of approach to South River to the original dimensions as dredged in 1873–75—300 feet wide at the entrance and 150 feet wide off Derby Wharf Light, 8 feet deep at mean low water—and for extending the channel with same depth up South River, reducing its width gradually to 100 feet near the inner end of Derby Wharf, and from that point excavating a channel 50 feet wide and 6 feet deep at mean low water to the head of navigation, at an estimated cost of $28,000 (H. Ex. Doc. No. 28, 51st Cong., 1st sess., with map). This improvement was completed in June, 1894, at a cost of $27,368.66.

Digitized by Google

7. LYNN HARBOR, MASS.

The original project for improvement of Lynn Harbor was submitted December 31, 1881, in accordance with the requirements of the river and harbor act of March 3, 1881, and is printed in Senate Executive Document No. 45, Forty-seventh Congress, first session, and in Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1882, page 544. An appropriation of $60,000 was made by the river and harbor act of August 2, 1882. Modifications of the project were defined in a report of the Board of Engineers for Fortifications and for River and Harbor Improvements, dated April 10, 1884, and approved by the Secretary of War April 21, 1884. (Printed in Annual Report for 1884, p. 524.) Further modifications were adopted in September, 1888, at which time the project was for a channel 200 feet wide and 10 feet deep at mean low water from the sea (at White Rocks) to a deep basin opposite Little Nahant, a distance of about 3,300 feet, and for a channel of the same width and depth and 6,900 feet long from the basin nearly opposite Sand Point to a point 400 feet inside the harbor line, and an anchorage basin 500 feet by 300 feet and 10 feet deep at mean low water; the upper part of the channel to be maintained by occasional dredging and the lower part by a training wall joining the land at Little Nahant, at an estimated cost of $182,000. The project was completed August 25, 1897, except the training wall, the necessity for which was not apparent, at an expenditure of $117,063.56.

The river and harbor act of July 13, 1892, appropriating $10,000 for Lynn Harbor, provided that the whole or any portion of the appropriation might be expended on the western channel (the channel leading to the mouth of Saugus River). Under this authority $5,000 was expended in obtaining in 1893 a channel 8 feet deep at mean low water and 150 feet wide for an aggregate length of 2,200 feet. Deterioration having occurred, the channel was redredged to its former dimensions in the fiscal year 1913, at an expenditure of $6,400 from allotments from appropriation provided by the river and harbor act of March 2, 1907, for emergencies in rivers and harbors.

The river and harbor act of June 13, 1902, provided for a channel 200 feet wide and 4,500 feet long from the sea to the deep basin opposite Little Nahant; from the basin nearly opposite Sand Point, a distance of 7,000 feet, to the anchorage basin, and the anchorage basin itself, 500 feet by 300 feet, all to the depth of 15 feet at mean low water, at an estimated cost of approximately $162,937. (H. Doc. No. 78, 56th Cong., 2d sess., with map; Annual Report for 1901, p. 1092.)

This project was completed in May, 1908, at an expenditure of $164,373.44. In addition $2,000 was expended for maintenance.

8. MYSTIC AND MALDEN RIVERS AND MYSTIC RIVER BELOW THE MOUTH OF ISLAND END RIVER, MASS.

(*b*) MALDEN RIVER.

The original project was proposed in 1880. It contemplated a channel 100 feet wide and 12 feet deep at mean high water up to the Charles Street Bridge, at an estimated cost of $35,000. In 1882 the

Digitized by Google

project was modified to secure a channel 12 feet deep at mean high water with a width of 100 feet up to the first drawbridge (Medford Street), thence 75 feet wide to the second drawbridge (Charles Street), at an estimated cost of $40,000, increased in 1884 to $47,000. The river and harbor act of August 2, 1882, appropriated $10,000 in furtherance of the improvement, which was expended in 1883 and 1884 in securing a channel with a least width of 50 feet (70 feet at turns) and depth of 12 feet at mean high water from the mouth to the Medford Street Bridge at Malden, a distance of 1.6 miles. No further appropriations were made until the river and harbor act of July 13, 1892. A channel 100 feet wide and 12 feet deep at mean high water was completed in 1897 to the Medford Street Bridge (the local officer having reported the river above that bridge to be unworthy of improvement by the United States). The expenditures were, to June 30, 1915, $24,986.39 for improvement and $44,763.61 for maintenance.

(*c*) MYSTIC RIVER BELOW THE MOUTH OF ISLAND END RIVER.

The original project, adopted by the river and harbor act of March 3, 1899, was for a channel 25 feet deep at mean low water and 300 feet wide from the mouth of the river in Boston Harbor, about 1 mile below the Chelsea Bridge, to a point 800 feet above the mouth of Island End River, at an estimated cost of $321,445.52. (H. Doc. No. 178, 55th Cong., 3d sess.) The estimate was reduced to $267,547.50 in 1899 as a result of a new survey made in the summer of that year.

The project was modified by the river and harbor act of June 25, 1910, in accordance with plan printed in House Document No. 1086, Sixtieth Congress, second session, by providing for the abandonment of the proposed 800-foot extension above the mouth of Island End River. The project as modified was completed in February, 1911, at an expenditure of $125,723.20. In addition, $10,281.92 was spent for maintenance.

The portion of the 25-foot project above Chelsea Bridge has been superseded by the 30-foot channel in Mystic River and the portion below the bridge by the 35-foot channel in Boston Harbor.

9. BOSTON HARBOR, MASS.

The original project, adopted by the act of March 2, 1825, was "for the preservation of the islands in Boston Harbor necessary to the security of that place," and to this end sea walls have been built and are being maintained on Great Brewster Island, Lovells Island, Gallops Island, Long Island Head, Rainsford Island, Deer Island, and Georges Island, and on Point Allerton. In all, about 3.75 miles of wall have been built.

The project adopted by the river and harbor act of March 2, 1867, was (as modified) to make the main ship channel from Nantasket Roads to Boston 23 feet deep at mean low water, 600 feet wide through the Narrows to President Roads, and 1,000 feet wide from President Roads to Boston. The project appears to have been completed by 1892, at which time the channel was 23 feet deep at mean

Digitized by Google

low water from Nantasket Roads to Boston, with a least width of 625 feet in the Narrows and 850 feet between President Roads and the city. In 1883 a channel was dredged through the bar, which extends from the north head of Long Island to Nixes Mate Shoal, 200 feet wide and 12 feet deep at mean low water, and about 550 feet long, and in 1892 this channel was widened to 300 feet and deepened to 15 feet at mean low water.

All expenditures to 1866, amounting to $546,526.10, appear to have been applied to the building and repair of sea walls. The expenditures since that time on the sea walls and the 23-foot channel project amount to $1,981,307.06, but the amounts applied to sea walls and the 23-foot channel project separately are not obtainable from the records at the present time. The aggregate of all expenditures on the projects for sea walls and 23-foot channel to June 30, 1915, is $2,527,833.16.

The project for a channel (known as the Nantasket Beach Channel) 100 feet wide and 9½ feet deep at mean low water from the mouth of Weir River to the steamboat wharf at Nantasket Beach, including the removal of a few bowlders at the mouth of the river and ledge near the wharf, was adopted by a proviso in the river and harbor act of June 14, 1880, and completed in 1883. Under a proviso in the river and harbor act of September 19, 1890, the channel was widened to 150 feet in 1891. In 1893 it was deepened to 12 feet at mean low water. The total expenditures were $33,820.76.

An extension of the main ship channel from near the Grand Junction Wharf (at East Boston) toward Jeffries Point, known as Jeffries Point Channel, was provided for in the river and harbor act of September 19, 1890. A channel 400 feet wide from Grand Junction Wharf to just east of Simpson's Patent Dry Docks, and 18 feet deep at mean low water, thence gradually narrowing to 250 feet and decreasing in depth to 15 feet at mean low water to a junction with the same depth off Jeffries Point, at an estimated cost of $50,000, was completed in 1893 at a cost of $47,743.75.

A project for the improvement of Charles River was adopted by a proviso in the river and harbor act of June 14, 1880. It was to widen and deepen the natural channel so that at mean low water it should be, from its mouth to Western Avenue Bridge, 200 feet wide and not less than 7 feet deep, thence to Market Street Bridge 80 feet wide and 6 feet deep; thence to the dam 60 feet wide and 2 feet deep, a total distance of 9 miles, at an estimated cost of $85,000 (S. Ex. Doc. No. 29, 45th Cong., 3d sess.; Annual Report for 1879, pp. 290–294). The estimate was increased to $125,000 in 1881 (Annual Report for 1881, pp. 516, 517). A channel of the projected dimensions was completed in 1884 to the Arsenal Street (now called Western Avenue) Bridge, being about 40 per cent of the whole project. The expenditures were $57,500. Funds in hand were carried to the surplus fund, pursuant to section 10 of the sundry civil act approved March 4, 1909. No further improvement is contemplated.

A project for the improvement of Chelsea Creek (upper) was adopted by a proviso in the river and harbor act of June 3, 1896, and was to make the channel about 5,500 feet in length next below the head of navigation, 150 feet wide and 18 feet deep at mean high

Digitized by Google

water, at an estimated cost of $65,000 (H. Ex. Doc. No. 162, 53d Cong., 3d sess., with map; Annual Report for 1895, p. 648). The project was completed in 1907. The expenditures to date are $73,071.49 for new work and $816.89 for maintenance.

The project for improvement of Fort Point Channel was adopted by the river and harbor act of August 5, 1886, and was for a channel 175 feet wide and 23 feet deep at mean low water from the entrance about 4,190 feet to near Federal Street Bridge, at an estimated cost of $100,000 (H. Ex. Doc. No. 206, 48th Cong., 2d sess., without map; Annual Report for 1885, p. 543). The estimate was reduced in 1887 to $78,750. The project was completed in 1909. The expenditures to date are $66,387.13 for new work and $9,514.05 for maintenance.

The project for the 27-foot channel was adopted by the river and harbor act of July 13, 1892, and was to widen the main ship channel from Nantasket Roads to Boston, 8½ miles, to 1,000 feet, and to deepen it to 27 feet at mean low water, at an estimated cost of $1,250,000 (for map see p. 554, Annual Report for 1894). The estimate was subsequently increased to $1,488,751. The project was completed in 1907. The expenditures to date are $1,414,390.99 for new work and $59,946.30 for maintenance.

The project for the 30-foot channel was adopted by the river and harbor act of March 3, 1899, and was to widen the Broad Sound Channel, 2 miles long from President Roads to the sea, to 1,200 feet and to deepen it to 30 feet at mean low water, at an estimated cost of $455,000 (H. Doc. No. 133, 55th Cong., 2d sess., with map; Annual Report for 1898, p. 886). The project was completed in 1905. The expenditures to date are $385,200 for new work and $69,800 for maintenance.

11. WEYMOUTH RIVER, MASS.

(*a*) WEYMOUTH FORE RIVER.

The original project was adopted by the river and harbor act of September 19, 1890, and was for obtaining for a distance of 7,000 feet below the head of navigation a channel with a uniform depth of 6 feet at mean low water, with a width of 100 feet to near Weymouth Landing, 80 feet thence to Braintree Bridge, and 50 feet thence 950 feet above that bridge, at an estimated cost of $40,000. Completed, except removal of four small ledges uncovered by the dredging, and maintained to 1906 by the United States. The expenditures were $40,000 for improvement and $2,750 for maintenance. The future maintenance of this improvement devolves upon the Commonwealth of Massachusetts.

The project adopted by the river and harbor act of March 3, 1905, embraced that portion of the river extending from its mouth in Hingham Bay about 3½ miles up to Weymouth Fore River Bridge at Quincy Point, and was to dredge a channel about 1 mile long, 300 feet wide, and 18 feet deep at mean low water up to that bridge, at an estimated cost of $57,500. The project was completed in June, 1907, at an expenditure of $55,000.

Digitized by Google

12. PLYMOUTH AND PROVINCETOWN HARBORS, MASS.

(a) PLYMOUTH HARBOR.

The original project was adopted by the act of May 26, 1824, and was "for repair of Plymouth Beach in the State of Massachusetts, and thereby prevent the harbor at that place from being destroyed," and all appropriations previous to 1875 appear to have been made for that purpose, the expenditures having amounted to $138,131.70 to 1899, when the present project for beach protection was adopted.

The original project for dredging was adopted by the river and harbor act of March 3, 1875, and was to provide a channel about 2,500 feet long, 100 feet wide, and 6 feet deep at mean low water from the channel in the inner harbor to Long Wharf, at an estimated cost of $28,000. The project was modified in 1877 so as to include the dredging of a basin about 900 feet long, 150 feet wide, and 8 feet deep at mean low water in front of the town wharves, at an estimated cost of $13,500; in 1884 to dredge the channel to a depth of 9 feet and widen it to 150 feet, rounding off its junctions with the main channel and basin, at a cost of $27,000; and in 1885 to deepen the basin to 9 feet, at a cost of $22,500. Under the project as modified, a channel 2,286 feet long, 150 feet wide, and 9 feet deep at mean low water, and a basin in front of the town wharves 866 feet long, 150 feet wide, and 9 feet deep at mean low water were obtained by 1893, at a cost of $50,514.89. Maintenance work has been done as follows: In 1899–1900, $10,212.63 were expended for redredging channel and basin, and in 1903, $3,954.42 for redredging turning basin.

(b) PROVINCETOWN HARBOR.

The original project, adopted by the act of May 20, 1826, was "for the preservation of the point of land forming Provincetown Harbor," and the project from 1826 continuously to this date has been, by building dikes and groins and by other sand-catching devices, to arrest the erosion and promote the accretion of the barrier of beach and sand dunes which protects and preserves the harbor. To this end work consisting of bulkheads of wood and stone, jetties of wood and brush, dikes, catch-sand devices, and extensive planting of beach grass was done at Beach Point, East Harbor Creek near High Head, Cove Section, Oblique Section, at Lanceys Harbor near Abel Hill, Wood End, and Long Point. Although in the vicinity of and below Wood End the timber structures were partially successful in accumulating sand moved by the wind, for the greater part of the distance between Abel Hill and Wood End they failed in the long run to accomplish their purpose, due to the absence of any great quantity of wind-driven sand and to the inability of light timber structures to withstand the inroads of the sea. The expenditures were $215,800.44 for improvement.

Digitized by Google

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE NEWPORT, R. I., DISTRICT.

2. HYANNIS HARBOR, MASS.

The earliest project was that adopted by the act of March 2, 1827, which provided for the construction of a breakwater to be built about seven-tenths of a mile from shore in an east-southeast direction. This made available to vessels passing through Nantucket and Vineyard Sounds the deep water to the north of the breakwater where the shore line became reentrant and afforded natural protection from storms other than those from a southerly direction. The work of constructing the breakwater was begun in 1828 and continued with but little interruption till 1837, when it was suspended, though unfinished, and nothing further was done till 1853. The substructure was riprap granite and sloped, and the superstructure was a vertical wall. This construction proved inadequate to withstand severe storms, and between the years 1852–1882 extensive repairs, increasing the width of base, sloping its vertical faces, and raising it to its projected height, were made.

At the completion of these, the breakwater was 1,170 feet long and about 10 feet high above mean low water, covering an anchorage area of about 175 acres, the entrance to which had a depth of about 15.5 feet. The sum of $123,431.82 had been expended on this project.

3. HARBOR OF REFUGE AT NANTUCKET, MASS.

The earliest project was that adopted by the act of March 2, 1827, which provided for dredging a channel through the outer bar, a bar which had formed across the entrance to the harbor and over which was a least depth of 6 feet at mean low water. Operations were in progress during a part of the years 1829, 1830, and 1831. Just how these were carried on is not known, but they proved ineffectual, one storm nearly filling up the dredged channel. The project was abandoned and nothing further was attempted in this direction. At the time this improvement was undertaken the whaling industry of Nantucket had reached large proportions, and the volume of the industry steadily increased until in 1846 it had reached a total of 63 whalers with a total tonnage of 24,661 tons. The cost of the work under this improvement was $45,734.45.

4. WOODS HOLE CHANNEL, MASS.

The original project was that of 1852, for which an appropriation of $2,500 was made for the improvement of Great Woods Hole Harbor. (The term hole on this part of the coast was applied generally by the first navigators to a shelter or harbor and not to a passageway.) This was spent in building a breakwater on its northern side to close a passage through which water-bearing sediment passed between it and Buzzards Bay. The report of this operation is found in the Annual Report of the Chief of Engineers for 1853. It would

Digitized by Google

appear the work was left incomplete, as an additional appropriation of $2,000 was solicited but not made. Private parties, however, continued the work and effectually closed the passage.

The next project was that adopted in 1879, with modifications in 1882, which provided for making a channel through the bar at the entrance to Little Harbor, deepening and widening the channel through the strait, and for building retaining walls on shore, a stone pier, and a wooden wharf, mainly for the use of the United States Fish Commission and incidentally for the use of other branches of the public service. The channel through the bar at the entrance to Little Harbor was deepened from 7½ feet to 10 feet, and later to 12 feet, at mean low water and 130 feet wide, and the channel through the strait was deepened to 9 feet at mean low water. The retaining walls on shore, stone pier, and wooden wharf were built for the use of the Fish Commission, the whole at a total cost of $113,599.92, of which $108,599.92 was for new work and $5,000 for maintenance.

5. NEW BEDFORD AND FAIRHAVEN HARBORS, MASS.

The original project adopted by the act of 1836 provided for the removal of a wreck and the dredging of a sand bar which had been formed by it. The sum of $10,000 was expended on this work. The project adopted by the act of March 3, 1875, provided for dredging a channel from the deep water near Palmers Island obliquely across the harbor to the wharves of New Bedford. It had a length of about 4,000 feet, width of 200 feet, and depth of 15 feet at mean low water. The sum of $20,000 was expended under this project.

The project adopted by the river and harbor act of August 11, 1888, and its modifications, provided for dredging a channel 200 feet wide from the deep water in Buzzards Bay to New Bedford Harbor, thence along the city wharf front 150 feet wide below and above the New Bedford and Fairhaven Bridge, an anchorage area about one-half mile long and 600 feet wide on the northerly side of the main channel between New Bedford and Fairhaven, and a channel 250 feet wide leading from the anchorage area through the draw in the bridge to the wharves above, with a turning basin at the upper end, in which the depth for all was 18 feet at mean low water. The channel 200 feet wide had a length of about 2 miles, the 150-foot width nine-tenths mile, and the 250-foot width five-tenths mile. This work was completed in 1906 at a total cost of $137,709.

6. TAUNTON RIVER, MASS.

The original project adopted by the act of July 11, 1870, provided for deepening the channel to 9 feet mean high water by dredging and rock removal. The greater part of this work was done in the section of the river between Burts Turn and Weir Bridge, in which were numerous shoals. The width of the channel under improvement varied from 60 to 70 feet, the former being the prevailing width. The work of removing the rock, which consisted of bowlders, was carried on at various points, chiefly at Peters Point, just above Dighton, at the Nook below Berkley Bridge, and at the Needles above the bridge. This work was completed in 1879 at a total cost of $63,000.

Digitized by Google

7. FALL RIVER HARBOR, MASS.

The original project was adopted by the river and harbor act of June 23, 1874, and provided for a channel 100 feet wide and 12 feet deep at mean low water, widening out at each end where it joins the main channel. Its location was along the wharf front immediately north of the Old Colony Steamboat Co.'s wharf where the shore line made a sharp inward curve. The channel as finally dredged was 160 feet wide and 1,500 feet long, with an additional width of 100 feet with 11 feet depth. A considerable part of this work consisted of the removal of bowlders found within the improved area. The project was completed in 1878 at a total cost of $30,000.

The project adopted by the river and harbor act of March 3, 1899, modified by the river and harbor act of June 13, 1902, provided for a channel 300 feet wide and 25 feet deep at mean low water through Mount Hope Bay to connect the deep water in the bay with the deep water in front of the city and for a channel of the same dimensions along the city wharf front between the Old Colony Wharf and the deep water at the upper end of the city front, a total distance of about 4.6 miles.

This project was completed in 1907 at a cost of $175,412, since which date $20,009.51 has been spent for maintenance, making the total cost of the two projects, with maintenance, $225,421.51.

8. PAWTUCKET (SEEKONK) RIVER, R. I.

The original project was adopted by the act of March 2, 1867, and provided for a channel 75 feet wide and 7 feet deep at low water. The improvement covered the section of the river between Butlers Point and the wharves at Pawtucket, a distance of about 2.3 miles, in which were a number of detached shoals of varying depths. The work of their removal was completed in 1876, at which time there was a channel 75 feet wide and 7 feet deep between Red Bridge and Pawtucket. In some of the shoals where there was a tendency to fill the depth was increased to 9 feet. The total cost of the improvement was about $50,000, the balance of $2,000 of the $52,000 appropriated was held for maintenance work.

The project adopted by the river and harbor act of July 5, 1884, provided for a channel 100 feet wide and 12 feet deep at mean low water from the mouth of the river, at Providence, up to Grant & Co.'s wharf in Pawtucket, thence with same depth and 40 feet wide through a ledge rock for a short distance farther, to Division Street Bridge, the head of navigation. The river and harbor act of March 3, 1899, modified this project by straightening that portion of the channel between Ten Mile River and Bucklins Island. The estimated cost of the project in 1883 was $382,500.

The improvement authorized in 1884 was completed in 1899, at which time the sum of $266,391.42 had been spent, and a channel 100 feet wide, with enlargements at the bends, and 12 feet deep from its mouth, at Providence, up to Grant & Co.'s wharf, thence same depth and 40 feet wide through a ledge rock to the head of navigation at Pawtucket, had been obtained. The actual distance covered by these operations was about 3.3 miles.

Digitized by Google

Under the act of March 3, 1899, a channel beginning at a point opposite Ten Mile River and running obliquely across the river to Phillipsdale, on the east side of the river, and rejoining the main channel at Bucklins Island, was dredged to the same depth and width as the main channel, at a cost of $16,053.49. This is now a part of the main channel.

9. PROVIDENCE RIVER AND HARBOR, R. I.

The act of August 30, 1852, appropriated $5,000 for deepening the channel at the Crook, a portion of the channel through the harbor just below Fox Point, and very crooked. The area covered by the improvement was about 150 feet by 840 feet, and the depth was increased from 4½ feet to 9 feet at mean low water.

The project adopted by the act of March 2, 1867, provided for deepening the channel at the Crook to 12 feet at mean low water. Subsequently the project was extended so as to include the channel through the harbor from Fields Point to Fox Point, a distance of about 1¾ miles. The channel as completed had a width of about 300 feet, for which there had been appropriated the total sum of $59,000.

The project adopted by the river and harbor act of June 18, 1878 (S. Ex. Doc. No. 34, 45th Cong., 2d sess.; Annual Report for 1878, p. 232), modified by the river and harbor act of August 2, 1882 (S. Ex. Doc. No. 145, 47th Cong., 1st sess.; Annual Report for 1882, p. 557), provided for a channel 300 feet wide and 25 feet deep at mean low water from the deep water in Narragansett Bay to Fox Point, Providence, for anchorage basins in the harbor of 600 feet width and 20 feet depth, 900 feet width and 12 feet depth, and 1,060 feet width and 6 feet depth, between Fields Point and Fox Point, and the removal of Bulkhead Rock, all at an estimated cost in 1882 of $675,000. This improvement was completed in 1895 and covered a distance of about 5¼ miles, at a total cost of $662,500.

The project adopted by the river and harbor act of August 5, 1886 (S. Ex. Doc. No. 42, 48th Cong., 2d sess.; Annual Report for 1885, p. 595), modified by the river and harbor acts of June 13, 1902, and March 5, 1905, provided for dredging Green Jacket Shoal to a depth of 25 feet at mean low water, limiting the area to be dredged by lines drawn 200 feet outside the harbor lines and parallel to them. The acts of 1902–1905 merged this project into the general project for enlarging the anchorage area of Providence Harbor. The expenditure, as a separate project, on the removal of this shoal was $104,250.

The project adopted by the river and harbor act of June 3, 1896 (Annual Report for 1886, p. 62), provided for a ship channel 400 feet wide and 25 feet deep at mean low water from Sassafras Point, in Providence Harbor, through Providence River and Narragansett Bay by the most direct route practicable, to the ocean by the way of the Western Passage, so called, at an estimated cost of $732,820. The contract was put under the continuing-contract system, and the project was completed in 1904, at a cost of $483,200.87.

The project adopted by the river and harbor act of June 13, 1902, modified by the river and harbor act of March 2, 1907 (H. Doc. No. 108, 56th Cong., 1st sess.), provided for an enlarged anchorage area of 25-foot depth, extending the full width of the harbor from Fox Point on the north to Long Bed and Sassafras Point on the south,

Digitized by Google

including the area known as Green Jacket Shoal, but excluding a small area adjacent to the western harbor line, between Harbor Junction Pier and Sassafras Point; enlarged by the act of 1907, so as to include an area of uniform width and same depth to the eastward of the main ship channel, between Long Bed and Kettle Point, at a total estimated cost of $698,528. The project was completed in 1909, at a total cost of $684,779.48.

The river and harbor act of June 25, 1910 (H. Doc. No. 606, 61st Cong., 2d sess.), adopted the project for extending the 25-foot-deep anchorage to the western harbor line, from just above Harbor Junction Pier to Fields Point, and for widening the 400-foot wide channel to 600 feet of the same depth, from Kettle Point to Gaspee Point, with certain easements of bends, at a total estimated cost of $459,000. It also contained a proviso that no part of the amount authorized by the act shall be expended until the Secretary of War shall have received satisfactory assurances that the city of Providence or other local agency will expend upon the improvement of the harbor front an equal sum. The conditions were all met by the city of Providence and the project was completed in 1913, at a cost of $459,000. The length covered by this improvement was about 4 miles.

10. NEWPORT HARBOR, R. I.

The original project adopted by the act of March 3, 1873, provided for the removal of the point of the shoal at the south end of Goat Island, and for dredging a channel of practicable width and 15 feet deep at mean low water between Goat Island and Lime Rock Light; for a channel 300 feet wide and 12 feet deep from the 12-foot curve into Commercial Wharf, then northerly along the new harbor line, same depth and 100 feet wide, to a point opposite Bull's wharf, about 1,000 feet, thence along same line with a depth of 7 feet to Long Wharf, 600 feet; for the construction of a jetty on Goat Island to arrest the sand coming around the island and depositing in the adjacent channel, all at an estimated cost of $28,500. This work was completed in 1876, except that not all the channel width between Goat Island and Lime Rock Light was made because of hardness of material, at a total cost of $28,500.

The project adopted by the river and harbor act of March 3, 1881, as modified and extended by the river and harbor acts of July 5, 1885, July 13, 1892, and August 17, 1894, provided for a channel with a least width of 750 feet and 15 feet deep at mean low water, from Narragansett Bay around the south end of Goat Island into Newport; for the extensions of the 13-foot and 10-foot deep anchorage basins; for the partial cutting off of the shoal spit at the southerly end of Goat Island and for the construction of jetties on its western shore, so as to prevent the erosion of the end of the island, and the drift of the sand, etc., around its western shore into the adjacent parts of the channel and harbor, and for the removal of Spindle Rock, a sharp, rocky spit near Rose Island, all at an estimated cost of $206,200. This project was completed in 1906, at a total cost of $244,695.71, of which $234,695.71 was for original work and $10,000 for maintenance.

The limits of the improvement covered an area of 90 acres within the harbor, included in which was a channel 750 feet wide and 15

Digitized by Google

feet deep at mean low water between Long Wharf and Lime Rock Light. The shoal spit at the south end of Goat Island and the 750-foot-wide channel at that point had been dredged to 15 feet depth, and Spindle Rock had been removed.

13. HARBOR OF REFUGE AT BLOCK ISLAND, R. I.

The original project was adopted by the act of July 11, 1870, and modified and extended by the river and harbor acts of August 5, 1886, August 11, 1888, and June 3, 1896, and provided for the construction of two breakwaters, one running out in a northerly direction from the shore on the east side, and the other L-shaped running out from the shore on the west side of the proposed harbor, so as to provide an inner harbor 800 feet square for small vessels, and an exterior harbor for larger ones, protected by the east or main breakwater which at its outer end curves harborward; also, for raising the main breakwater to its projected height and stopping sand leaks between certain joints and for dredging to 10 feet depth at mean low water, the main inner harbor. This work was completed in 1908, at a total cost of $531,219.23 of which $500,764.07 was for original work and $30,455.14 for maintenance.

The main or east breakwater was built a distance of 1,950 feet, 300 feet of which adjacent to the shore forms the east side of a small inner basin. The west breakwater, L-shaped, was built 1,100 feet in length, forming two sides of the inner harbor 800 feet square.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE NEW LONDON, CONN., DISTRICT.

---

1. PAWCATUCK RIVER, R. I. AND CONN.

The original project and its extensions up to the time of the adoption of the present project, were not defined in terms by the river and harbor acts making the appropriations, but followed plans presented in special reports to the Chief of Engineers, funds for the execution of which were subsequently appropriated. The original plan for improvement recommended a channel in the river having a depth of 5 feet at mean low water and a width of 75 feet, extending from Certain Draw Point to Westerly (H. Ex. Doc. No. 60, 41st Cong., 3d sess., and Annual Report for 1871, p. 743). Funds for the work were appropriated by the river and harbor act of March 3, 1871. An extension to the project to provide a channel 8 feet in depth at mean low water and 100 feet wide, from the lower wharves at Westerly down to deep water, and 40 feet in width from the lower to the upper wharves, was recommended in a subsequent report (H. Ex. Doc. No. 183, 48th Cong., 2d sess., and Annual Report for 1885, p. 622), and funds appropriated by the river and harbor act of August 5, 1886, and subsequent acts were applied to this extension. The project was also extended to provide a channel through Little Narragansett Bay, 7½ feet in depth at mean low water and 200 feet in width (H. Ex.

Digitized by Google

Doc. No. 70, 44th Cong., 1st sess., and Annual Report for 1876, p. 217), and funds appropriated by the river and harbor act of August 5, 1886, and subsequent acts were applied to this extension. At the time of the adoption of the present project, in 1896, the project then existing for the improvement of the Pawcatuck River comprised, therefore, a channel 7½ feet deep and 200 feet wide through Little Narragansett Bay; and a channel 8 feet deep and 100 feet wide to the lower wharves at Westerly and of the same depth and 40 feet wide between the lower and upper wharves at Westerly.

2. HARBOR AT STONINGTON, CONN.

The original project adopted by the river and harbor act of May 23, 1828, provided for the "erection of piers or other works * * * for the purpose of making * * * a good and secure harbor." A stone pier 740 feet long, with its top 12 feet wide and about 8½ feet above mean low water, outer slope 1 on 3 and inner slope 3 on 1, was built on the east side of the inner harbor (Annual Report for 1879, p. 327). An extension to the project to provide for deepening and dredging the harbor and its approaches to 12 feet at mean low water (S. Doc. No. 23, 42d Cong., 2d sess., and Annual Report for 1872, p. 917) was adopted by the river and harbor act of March 3, 1873. The project was further extended to include the construction of a breakwater 2,000 feet long at the westerly side of the entrance (Annual Report for 1875, p. 243), funds appropriated by the river and harbor act of March 3, 1875, and subsequent acts being applied to this extension.

At the time of the adoption of the present project, in 1880, the project then existing for the improvement of Stonington Harbor comprised, therefore, the erection of piers or other works at the east side of the inner harbor, the dredging of the harbor and its approaches to a depth of 12 feet at mean low water, and the construction of a breakwater 2,000 feet long at the westerly side of the entrance.

3. MYSTIC RIVER, CONN.

The original project provided for a channel 100 feet in width and 15 feet in depth at mean low water from Fishers Island Sound to the highway bridge at Mystic and the reducing of five bends (Annual Report for 1889, p. 746). Funds for the work were appropriated by the river and harbor act of September 19, 1890, and subsequent acts.

4. NEW LONDON HARBOR, CONN.

Operations in New London Harbor prior to the adoption of the existing project were inaugurated as modifications to the project for the improvement of the Thames River. The original work was in accordance with a plan printed in the Annual Report of the Chief of Engineers for 1878, page 397, which recommended the removal to a depth of 16 feet at mean low water, of a shoal lying east of the Central Vermont Railroad pier, funds for which were provided by the river and harbor act of June 14, 1880, from the appropriation for Thames River and thereafter by specific appropriations for the

Digitized by Google

improvement of New London Harbor. The river and harbor act of July 13, 1892, and subsequent acts authorized the expenditure of a part of the appropriations for the improvement of Thames River for dredging Shaws Cove to a depth of 12 feet at mean low water (H. Doc. No. 73, 51st Cong., 2d sess., and Annual Report for 1891, p. 833). The river and harbor act of June 25, 1910, consolidated the improvement of Shaws Cove with that of New London Harbor. At the time of the adoption of the present project, in 1902, and its modification, in 1910, the project then existing for the improvement of New London Harbor, therefore, formed a part of the project for the improvement of the Thames River and comprised the removal, to a depth of 16 feet at mean low water, of a shoal lying east of the Central Vermont Railroad pier and the dredging to a depth of 12 feet at mean low water of Shaws Cove.

5. THAMES RIVER, CONN.

The original project, adopted by the river and harbor act of July 4, 1836, provided for "deepening the channel of the River Thames leading into Norwich Harbor." The work consisted of the building of 11 piers or wing dams, adding to 3 wings already built by private enterprise, and the dredging of a channel about 100 feet wide and 14 feet deep at high water, all in the portion of the river immediately below Norwich (Annual Report for 1873, p. 983).

7. CONNECTICUT RIVER BELOW HARTFORD, CONN.

The original project adopted by the river and harbor act of July 4, 1836, provided for the improvement of the harbor of Saybrook by removing the bar at the mouth of the Connecticut River (Annual Report for 1873, pp. 990 and 996). The improvement was resumed by authority of the river and harbor act of March 3, 1871, under a plan which provided for a channel 200 feet wide and 8½ feet deep at mean low water at Saybrook Bar; thence 100 feet wide and 8 feet deep at low water to Hartford; the removal of Chester Rock; and pile shore protection at Hartford and Wethersfield (H. Doc. No. 153, 40th Cong., 2d sess., and Annual Report for 1868, p. 754). It was modified by the river and harbor act of June 10, 1872, to provide a channel 400 feet wide and 9 feet deep at mean low water across Saybrook Bar, to be secured by the construction of jetties and dredging (H. Doc. No. 125, 42d Cong., 3d sess., and Annual Report for 1873, pp. 986 and 997). It was again modified by the river and harbor act of March 3, 1881, to provide for revetment and regulating dikes, while the depth of the channel was increased to 10 feet (H. Doc. No. 42, 46th Cong., 2d sess., and Annual Report for 1880, pp. 396 and 417). It was further modified to provide for completing the jetties at the mouth of the river at Saybrook to a height of 5 feet at high water, with top width of 6 feet, and for deepening the channel at Saybrook Bar to 12 feet at mean low water (Annual Report for 1888, p. 536). And, finally, the project was modified to provide for raising the height of the Hartford dike to 15 feet above low water, if found necessary (Annual Report for 1890, p. 614).

Digitized by Google

8. HARBOR OF REFUGE, DUCK ISLAND HARBOR, CONN.

The original project, adopted by the river and harbor act of September 19, 1890, provided for the construction of three riprap breakwaters—one extending 3,000 feet westerly from Duck Island, one extending 1,750 feet northeasterly from Duck Island, and one extending 1,130 feet southwesterly from Menunketesuck Point, each with top 10 feet wide and 10 feet above mean low water, with inner slope of 1 on 1 and outer slope of 2 on 3 (Annual Report for 1887, p. 641). Prior to the adoption of the present project, the breakwater extending westerly from Duck Island only had been constructed and for a length of but 2,697 feet and with reduced sectional area.

10. NEW HAVEN HARBOR, CONN.

The original project, adopted by the river and harbor act of August 30, 1852, provided for the removal of Middle Rock at the entrance to the harbor. The act of June 10, 1872, extended the scope of this feature of the project by providing for the removal of rocks in the harbor without especial designation. With the facilities then available, the work proved more difficult than was expected, and was not continued after 1875, when the harbor breakwaters were proposed.

The original project for the channel dredged in the harbor, and its subsequent extensions up to the time of the adoption of the present project were not defined in terms by the river and harbor acts making the appropriations, but followed plans presented in annual or special reports to the Chief of Engineers, funds for the execution of which were subsequently appropriated. The original plan for dredging recommended a channel to the wharves 14 feet deep at mean low water and 200 feet wide (H. Ex. Doc. No. 95, 41st Cong., 3d sess., and Annual Report for 1871, p. 771). Funds for this work were appropriated by the river and harbor act of March 3, 1871. An extension to the project to provide a channel 16 feet deep and 200 feet wide through Fort Hale Bar was recommended (H. Ex. Doc. No. 137, 42d Cong., 1st sess., and Annual Report for 1872, p. 860), and funds therefor were appropriated by the river and harbor act of June 10, 1872. The next extension was to increase the width of the channel above Long Wharf to 400 feet, recommended in a report of February 9, 1875, funds for which were appropriated by the river and harbor act of March 3, 1875. This was followed by an increase in the width of the channel below Long Wharf to 400 feet with depth of 16 feet (Annual Report for 1877, p. 212), funds for beginning which were appropriated by the river and harbor act of June 14, 1878. An increase in depth to 16 feet above Long Wharf was recommended (Annual Report for 1879, Part I, p. 336), and the first funds for this work were appropriated by the river and harbor act of March 3, 1879. The construction of a dike at Sandy Point for the improvement of Fort Hale Bar (Annual Report for 1881, p. 592) was undertaken with funds appropriated by the river and harbor act of August 2, 1882, under plans approved by the Board of Engineers October 2, 1882. The Annual Report of the Chief of Engineers for 1884, page 645, contains the recommendation that the channel be widened to provide greater anchorage space, and under the appropriation of July 5, 1884, the extra width, with depths of

Digitized by Google

12 and 8 feet, were provided in the upper channel, giving widths above Long Wharf of from 400 to 700 feet.

At the time of the adoption of the present project, in 1899, the project then existing for the improvement of New Haven Harbor comprised, therefore, a channel in general 16 feet deep and from 400 to 700 feet wide from Long Island Sound to the head of the harbor, and a dike to contract the tidal flow at Fort Hale Bar.

12. MILFORD HARBOR, CONN.

The original project, adopted by the river and harbor act of June 23, 1874, provided for the construction of a breakwater and jetties and dredging a channel 100 feet wide and 4 feet deep at the mouth of the harbor (H. Doc. No. 107, 42d Cong., 3d sess., and Annual Report for 1873, p. 1042). The project was extended to include a channel, subsequently dredged 60 feet wide and 4 feet deep, to the Town Dock, and to include an auxiliary jetty southward from Burns Point (Annual Reports for 1878, p. 402, and for 1879, p. 342), funds appropriated by the river and harbor act of June 18, 1878, being applied to these extensions. The project was again modified to include the extension of the channel, 60 feet wide and 4 feet deep, to the wharf next above the Town Dock (Annual Report for 1880, p. 458), funds for which were appropriated by the river and harbor act of June 14, 1880. The project was further modified to provide a channel 100 feet in width and 8 feet deep at mean low water at the entrance to the harbor (Annual Report for 1882, p. 614), funds for which were appropriated by the river and harbor act of August 2, 1882.

14. BRIDGEPORT HARBOR, CONN.

Prior to the adoption of the existing project the improvement of Bridgeport and Black Rock Harbors was conducted as separate projects. The original project for Bridgeport Harbor was adopted by the river and harbor act of July 4, 1836, and provided for deepening the channel leading into the harbor. A channel 60 feet wide and 8 feet deep was dredged through the outer bar (Annual Report for 1871, p. 788). Further operations under the project were conducted as outlined in the Annual Report of the Chief of Engineers for 1871, page 789, with funds appropriated by the river and harbor act of August 30, 1852.

A second project was adopted by the river and harbor act of March 3, 1871, providing for a channel 100 feet wide and 14 feet deep at mean low water up to the city wharves, and a jetty or breakwater on the east side of the harbor entrance, extending out about 3,000 feet from Long Beach (H. Doc. No. 60, 41st Cong., 3d sess., and Annual Report for 1871, p. 788); modified to provide a channel 100 feet wide and 12 feet deep to the city wharves (Annual Report for 1876, p. 227), for which funds appropriated by the river and harbor act of March 3, 1875, were applied; modified to provide a channel 300 feet wide and 12 feet deep to the city wharves, and for a channel 100 feet wide and 9 feet deep from the lower bridge to the horse-railroad bridge (East Washington Avenue) (Annual Report for

Digitized by Google

1878, p. 53), for which funds appropriated by the river and harbor act of June 18, 1878, were applied; modified to provide an anchorage basin on the west side of the channel inside the inner beacon (Annual Report for 1883, p. 520), for which funds appropriated by the river and harbor act of August 2, 1882, were applied; modified to extend the channel 100 feet wide and 9 feet deep above the horse-railroad bridge, for which funds appropriated by the river and harbor act of August 11, 1888, were applied, and to construct a breakwater from the Tongue to the inner beacon, for which funds were appropriated by the river and harbor act of September 19, 1890 (Annual Report for 1889, p. 695); modified to provide increased width in the anchorage basin inside the inner beacon (Annual Report for 1893, p. 80), for which funds appropriated by the river and harbor act of July 13, 1892, were applied; modified to provide a channel 100 feet wide and 15 feet deep at mean low water through the outer bar (Annual Report for 1895, p. 793), for which funds appropriated by the river and harbor act of August 17, 1894, were applied; and finally modified to provide a channel 300 feet wide and 15 feet deep to the inner beacon, thence 200 feet wide and 15 feet deep to the lower bridge, and a channel 200 feet wide and 12 feet deep up to the causeway at Yellow Mill Pond (H. Doc. No. 61, 54th Cong., 1st sess., and Annual Report for 1896, p. 707), for which funds appropriated by the river and harbor act of June 3, 1896, were applied.

The original project for Black Rock Harbor was adopted by the river and harbor act of July 4, 1836, and provided for the construction of a sea wall to preserve Fayerweather Island (Annual Report for 1885, p. 653). A second project was adopted by the river and harbor act of July 5, 1884, which provided for a breakwater about 2,600 feet long, connecting Fayerweather Island and the mainland, and for a channel up the east creek, known as Cedar Creek, 80 feet wide and 6 feet deep at mean low water (S. Doc. No. 50, 48th Cong., 1st sess., and Annual Report for 1884, p. 667).

15. NORWALK HARBOR, CONN.

The original project adopted by the river and harbor act of June 10, 1872, provided for a channel 100 feet wide and 6 feet deep at mean low water to Norwalk (S. Doc. No. 23, 42d Cong., 2d sess., and Annual Report for 1872, p. 901); modified to provide a channel 100 feet wide and 8 feet deep from the outer harbor to South Norwalk, and thence 6 feet deep to Norwalk (Annual Report for 1881, p. 609), for which funds appropriated by the river and harbor act of June 14, 1880, were applied; extended by the river and harbor act of August 18, 1894, to include the removal of a shoal at Ferrys Point and the widening of the bend near Keysers Island (Annual Report for 1895, p. 805). A second project was adopted by the river and harbor act of June 3, 1896, providing for a channel 150 feet wide and 10 feet deep at mean low water up to the railroad bridge at South Norwalk, and the widening of two bends at the harbor entrance (H. Doc. No. 50, 54th Cong., 1st sess., and Annual Report for 1896, p. 813).

Digitized by Google

16. HARBORS AT FIVEMILE RIVER, STAMFORD, SOUTHPORT, GREENWICH, AND WESTPORT HARBOR AND SAUGATUCK RIVER, CONN.

(B) STAMFORD HARBOR, CONN.

The original project was adopted by the river and harbor act of August 5, 1886, and provided for a channel in Mill Creek, now called the West Branch, 5 feet deep at mean low water, 80 feet wide, and about 6,600 feet long (S. Doc. No. 50, 48th Cong., 1st sess., and Annual Report for 1884, p. 672).

(C) SOUTHPORT HARBOR, CONN.

The original project, adopted by the river and harbor act of March 2, 1829, provided for improving the navigation of the Mill River by removing obstructions and constructing such works as will prevent the sand from filling up the channel. A breakwater and dike were built and a small amount of dredging done (Annual Report for 1871, p. 824). Funds appropriated by the river and harbor act of August 14, 1876, were applied to dredging a channel 60 feet wide and 4 feet deep at mean low water from the outer breakwater to above the end of the breakwater (Annual Report for 1876, p. 230), and funds appropriated by the river and harbor act of March 3, 1881, were applied to increasing the width of the outer channel to 100 feet (Annual Report for 1881, p. 607).

(E) WESTPORT HARBOR AND SAUGATUCK RIVER, CONN.

The original project was authorized by the river and harbor act of March 2, 1827, and provided for removing obstructions to navigation and protecting the harbor by a suitable work to prevent the washing of the sand from Cedar Point into the harbor. The project was modified by the river and harbor act of July 4, 1836, to include cutting a channel through Great Marsh. The work accomplished is outlined in the Annual Report of the Chief of Engineers for 1871, page 801.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE FIRST NEW YORK, N. Y., DISTRICT.

---

1. PORT CHESTER HARBOR, N. Y.

Pursuant to the requirements of the river and harbor act of March 3, 1871, a report upon a survey of this harbor was submitted December 28, 1871. (S. Doc. No. 23, 42d Cong., 2d sess., and Annual Report for 1872, p. 809, without map.) The project recommended in this report was adopted by act of June 10, 1872. It provided for the removal of Sunken Rock to 11 feet and of Salt Rock to 9 feet at mean low water, and the construction of a breakwater at Byram

Digitized by Google

Point to be 400 feet long with the top extending 13 feet above mean low water. The estimated cost of this work was $96,632.

In 1884 (Annual Report for 1884, p. 712) this project was modified so as to provide for a channel 60 to 100 feet wide and 2½ feet deep at mean low water up to the vicinity of the bridge at Port Chester. Further modification of the project was made in 1888 (Annual Report for 1890, pp. 650 and 651) by omitting the removal of Sunken Rock and changing the location of the breakwater so as to make it extend from Sunken Rock toward the shore, and also by reducing the estimated cost to $52,000.

By act of March 3, 1899, appropriating $25,000 for this harbor, the project of 1872 was enlarged by requiring that this amount be "expended in enlarging the channel below and up to Town Dock to a depth of 12 feet and a width of 70 feet, and from Town Dock to the steamboat wharf to a depth of 9 feet and a width of 60 feet." The appropriation of this $25,000 increased the estimated cost from $52,000 to $77,000. (Annual Report for 1900, pp. 1378, 1422, and 1423.) The project was further enlarged by act of March 2, 1907, by providing for the removal of ledges of rock opposite the southerly point of Fox Island, appropriating therefor the sum of $6,500 and thereby increasing the estimate to $83,500.

The amount expended on this project, as modified and enlarged up to the time of commencing work on the existing project adopted by act of June 25, 1910, was $91,369.12, of which amount $75,000 was for new work and $16,369.12 was for maintenance.

For maps of the locality and additional details concerning this harbor prior to the adoption of the existing project see Annual Report of the Chief of Engineers for 1885 (contains map), page 658; 1889 (contains map), page 716; 1895 (no map), page 865; 1897 (no map), page 1084; and 1900 (no map), pages 1378 and 1423.

2. MAMARONECK HARBOR, N. Y.

A report upon a survey of this harbor was submitted January 18, 1882, pursuant to the requirements of the river and harbor act of March 3, 1881 (S. Doc. No. 84, 47th Cong., 3d sess., and Annual Report for 1882, p. 637, without maps). The project for improvement recommended in this report was adopted by act of August 2, 1882. It provided for the removal of Round Rock to a mean low-water depth of 4 feet; Bush Rock, part of Nells Rock, Inner Steamboat Rock, Outer Steamboat Rock, and Little Nanhook to a depth of 7 feet; for dredging a channel 100 feet wide and 7 feet deep at mean low water from Long Island Sound to the old steamboat wharf on Harbor (Hog) Island, and thence 80 feet wide and 4 feet deep to the upper wharves; and in closing a small channel east of Grassy Knoll. Estimated cost, $43,000.

Under date of April 27, 1899, the project was modified by omitting Nells Rock, Little Nanhook, and Outer Steamboat Rock, and by providing for the extension of the channel of 100 feet width and 7 feet depth to the upper wharves (Annual Report for 1899, p. 1211). No change was made in the estimate of cost. Under this modification Round Rock, Bush Rock, and Inner Steamboat Rock were reported removed to the projected depths, and a channel 7 feet

Digitized by Google

deep and 70 to 100 feet wide was dredged from the harbor entrance to the turn at Harbor (Hog) Island, and thence 100 feet wide to the upper wharves. The cost of this work was $40,000, of which amount $35,371.50 was for new work and $4,628.50 was for maintenance.

For additional details concerning this harbor prior to the project of June 25, 1910, see Annual Reports of the Chief of Engineers for the fiscal years ending June 30, 1886, page 658; 1900, page 1381; and 1903, page 859. Sketch maps are contained in the reports for 1886 and 1903.

3. LARCHMONT HARBOR, N. Y.

A report upon a survey of this harbor was submitted November 26, 1889, pursuant to the requirements of the river and harbor act of August 11, 1888 (H. Doc. No. 40, 51st Cong., 1st sess., with map, and Annual Report for 1890, p. 65, without map). The project for improvement based upon this report was adopted by act of September 19, 1890. It provided for the building of two breakwaters, one to extend from Umbrella Rock to Umbrella Point and the other from Huron Rock to Long Beach. Estimated cost, $105,000. Work on the project was suspended in 1891, after completing 74 linear feet of the Umbrella Breakwater and 64 linear feet of the Huron Breakwater at a cost of $5,000. No further work was done here until 1900, subsequent to the adoption of the present project in 1899.

For additional details concerning this harbor, see Annual Reports of the Chief of Engineers for the fiscal years ending June 30, 1891, page 800; 1900, page 1383; and 1903, page 860. This latter report contains a map of the locality.

4. ECHO BAY HARBOR, N. Y.

A report upon a survey of this harbor was submitted December 20, 1875, in compliance with the provisions of the river and harbor act of March 3, 1875 (Annual Report for 1876, p. 263, without map). The project recommended in this report was adopted by the act of June 18, 1878. It provided for the removal of Start Rock to a depth of 7 feet below mean low water and Sheepshead Reef to a depth of 9 feet. Estimated cost $38,955.38.

In May, 1889, residents of New Rochelle submitted a petition asking for the expenditure of the available funds in dredging. This dredging was authorized by the Chief of Engineers (Annual Report for 1890, p. 653), and as the result of the expenditure of the balance of funds then available, amounting to $3,043.97, a channel 4 feet deep at mean low water, 40 feet wide, and 1,050 feet long was completed October 25, 1889. This channel extended from deep water to about 300 feet from the head of the harbor. On April 1, 1906, permission was granted to the New Rochelle Coal & Lumber Co. to advance its wharf line so as to include this channel within the wharf area and to dredge in front of it. This was done, and there is now a channel here not less than 6 feet deep at mean low water, connecting with the main channel at Hudson Park (Beauford Point).

Digitized by Google

By act of March 3, 1899, a further examination of the harbor was directed to be made, and in compliance therewith a report was submitted December 9, 1899 (H. Doc. No. 235, 56th Cong., 1st sess., with map, and Annual Report for 1900, p. 1424, without map), recommending the completion of the improvement commenced in 1878 and suspended in 1883, by completing the removal of Start Rock and Sheepshead Reef to the depth adopted in the project of 1878. Estimated cost $17,000. When this estimate was submitted a balance of the previous estimate (report of Dec. 20, 1875) amounting to $17,000 had not yet been appropriated.

In compliance with the requirements of the river and harbor act of March 3, 1905, a report upon a survey of Long Rock was submitted June 27, 1906 (H. Doc. No. 182, 59th Cong., 2d sess., no map). This report recommended the removal of Long Rock to a depth of 6 feet below mean low water at an estimated cost of $17,871.70. The work contemplated under the original project for improvement, and its subsequent modification as outlined above, was completed at a cost of $47,379.41, of which amount $47,369 was for new work and $10.41 was for maintenance. The cost of the improvements made under this project and its modifications was $9,458.08 less than the totals of the estimates submitted. There was received from sales $1.25.

For additional details prior to the adoption of the existing project, see Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1900, pages 1423–1429. A sketch map is printed in the Annual Report for 1903, page 862.

5. EAST CHESTER CREEK, N. Y.

A report upon a survey of this creek was submitted January 19, 1872 (H. Doc. No. 242, 42d Cong., 2d sess., without map, and Annual Report for 1872, p. 812, without map) pursuant to the requirements of the river and harbor act of March 3, 1871. The project for improvement recommended in this report provided for a channel 9 feet deep at mean high water and 100 feet wide up to a point about 3,000 feet above Lockwoods at Boston Post Road; the excavating of a basin at the upper end of the channel; and the diking and revetting of the banks of the dredged cuts, at an estimated cost of $136,505 (Annual Report for 1890, pp. 657–659). It was adopted by the act of March 3, 1873, which appropriated $25,000 for commencing work thereunder. Pending the transfer of land to the United States by the State of New York, active operations were delayed until April 16, 1877. Subsequent to the date of adopting the project in 1873 and up to 1891, several modifications of the plan of improvement and of estimated cost thereof were considered (Annual Report for 1891, pp. 806–811). In 1891 the estimated cost for completing the improvement was finally fixed at $124,000; in this estimate part of the dike construction and the excavation of the basin were omitted (Annual Report for 1891, p 809).

The project was completed in 1899, at a cost of $89,091.22. Up to the time of commencing work under the existing project in 1910, the total expenditures amounted to $115,502, of which amount $89,091.22, being $34,908.78 less than the estimate, was for new work, and $26,410.78 was for maintenance.

Digitized by Google

For additional details prior to the adoption of the existing project, see Annual Reports of the Chief of Engineers for the fiscal years ending June 30, 1897, page 1089, and 1904, page 1061. A sketch map is printed in the report for 1904, page 1017.

7. BRONX RIVER, N. Y.

The original project (Annual Report for 1896, p. 733) for the improvement of this stream was adopted by the river and harbor act of June 3, 1896. It provided for making a channel 4 feet deep at mean low water and 100 feet wide from the mouth to Barlow Street (now Falconer Street); thence to Dongan Street (now Garrison Avenue), 60 feet wide; and thence to the head of navigation, 50 feet wide, the work to be done by dredging and rock removal at an estimated cost of $85,985.

For additional details prior to the adoption of the existing project, see Annual Reports of the Chief of Engineers for fiscal years ending June 30, 1881, page 665; 1891, page 949; 1900, page 1389; and 1912, page 1469. A sketch map of the locality is printed in the report for 1912, page 1470.

8. EAST RIVER AND HELL GATE, N. Y.

Work on the improvement of the East River was commenced on August 20, 1851, with funds furnished by citizens of the city of New York. This work was continued until February 28, 1852, by which date the removal of two rocks in Hell Gate had been completed while four others had been partially removed. A part of Diamond Reef was also removed. The total expenditure for this work was $13,861.59.

On August 30, 1852, Congress appropriated $20,000 "for the further improvement of the harbor of New York by removing the rocks at Hell Gate and Diamond Reef, in the East River." This sum was expended in removing Pot Rock in Hell Gate to 20.5 feet below mean low water.

9. HARLEM RIVER, N. Y.

A report upon a survey of this river (H. Doc. No. 174, 43d Cong., 1st sess., without map, and Annual Report for 1874, pt. 2, p. 169) was submitted February 19, 1874, in compliance with the requirements of the river and harbor act of March 3, 1873. A project based upon the recommendations made on this report was adopted by river and harbor act of June 23, 1874. It provided for the removal of four piers of an old bridge between East One hundred and fourteenth Street and Wards Island, the removal of Candle Factory Reef at the foot of East One hundred and twenty-second Street, and the removal of small reefs off East One hundred and twenty-fifth Street and at the mouth of Mott Haven Canal to a depth of 12 feet at mean low water, at an estimated cost of $167,875.56.

Operations under this project were commenced during the fiscal year ending June 30, 1875, and up to October 7, 1875, when work was suspended, three bridge piers off the foot of East One hundred and fourteenth Street had been removed, and a mean low-water depth of 14½ feet had been secured over a reef off East One hundred and

Digitized by Google

twenty-fifth Street (Annual Report for 1876, p. 244). There was expended on this work $21,000.

12. BURLINGTON HARBOR, VT.

The original project adopted July 4, 1836, provided for the formation of an artificial harbor in front of the city of Burlington by constructing a breakwater parallel with the shore and about 1,000 feet distant from the docks and wharves. Work was commenced in 1836 and continued at intervals as funds became available until 1857, when 1,069 feet of breakwater had been completed. In 1867 the project was extended so as to provide for the construction of an additional 1,500 feet of breakwater to the north and west of the existing structure. As it was reported at the time that an extension to the south was inadvisable and that an extension to the north on the original alignment would seriously contract the area of the harbor, the separate location of the new breakwater was decided upon. However, as constructed, this extension was continued from the north end of the old portion.

Up to 1874 there were completed 831 feet of the northerly extension, but the wharves in the meanwhile having been constructed to the southward along the shore line a diversion of available funds for a southerly extension in order to protect the new wharves was authorized, and such an extension, 617 linear feet in length, was built. In June of the same year a plan was adopted for a further extension northward of the breakwater for a distance of 2,000 feet, the cost being estimated at $340,000. (Annual Report for 1874, p. 275.)

In 1884 another southerly extension of the breakwater was approved, and prior to 1886, when the present project was adopted, a breakwater of a total length of 3,551 feet had been constructed and maintained.

Prior to 1886 the breakwater as built consisted of vertical wooden cribs of a width of about 35 feet extending from the lake bottom to an elevation of about 8 feet above low lake level filled with rubble stone and sheathed with plank on the exposed face.

13. NARROWS OF LAKE CHAMPLAIN, N. Y. AND VT.

The original project (based on H. Doc. No. 138, 48th Cong., 2d sess.), adopted by the act of August 5, 1886, had for its object the removal of such obstructions in the channel of the Narrows as would afford a least depth of 12 feet and a least width of 150 feet from Whitehall to the Elbow, and 12 feet depth and 200 feet width along Cedar Mountain and across Kenyon Bay, at an estimated cost of $80,000. Under appropriations in 1886 and 1888, aggregating $45,000, the project was completed at a little more than half the estimated cost, which was due to the dredging having been accomplished at 17 cents and 10.8 cents per cubic yard, instead of 25 and 30 cents, as estimated. The resulting channel, however, being found deficient in width at certain sharp bends, a supplementary project was adopted in 1890 involving dredging in widening the channel at these localities, at an estimated cost of $21,000. The original project

Digitized by Google

as thus extended in 1890 was completed in 1896 at a cost of $63,500 and a channel of project depth was created thereby.

14. HUDSON RIVER, N. Y.

From 1797 to 1834 the improvement of the Hudson River was carried on solely by the State of New York, and from 1834 to 1892 by the State in conjunction with the Federal Government. It consisted in the construction of jetties and in dredging, which resulted, however, in no permanent improvement of the river. In its natural condition the channel from Waterford to Hudson was narrow and crooked, with banks 650 to 3,000 feet apart and a navigable depth at mean low water of 3½ to 4 feet between Albany and Waterford, 7½ feet between Albany and New Baltimore, 11 feet between New Baltimore and Coxsackie, and not less than 12 feet between Coxsackie and Hudson. Below Hudson a natural depth existed of about 25 feet, barring a few shoals. Above Hudson the river in its navigable state was at many places divided by shoals and islands into two or more channels and was navigable for shallow-draft vessels only. Its commercial importance, however, was great, as it afforded the chief traffic outlet for the cities of Albany and Troy and connected the Champlain and Erie Canals, opened in 1825, with the Atlantic Ocean. The former canal entered the Hudson River in the pool formed by the dam at Troy, which was completed by the State of New York in 1823. Railroads, though being built, were negligible as competing carriers. Other connections between the Hudson and the main Erie and Champlain Canals were by canals opening into the Hudson at Watervliet opposite Troy and at Albany.

A board of engineers was convened in 1834 to examine into projects for further improvement and to devise a plan with estimates of cost for the improvement of the river. As a result the original project for the improvement (H. Doc. No. 189, W. D., 22d Cong., 1st sess.) was adopted that year. The estimated cost was $819,634.10. This project was modified in 1852 and in 1866 and, as modified, had for its object the securing of a navigable channel of sufficient width and 9 feet depth at mean low water between Troy and Albany and 11 feet between Albany and New Baltimore, to be obtained by dredging and protected by the construction of longitudinal dikes and occasional intersecting cross dams, thus forming tidal basins. In carrying on this work $1,667,938 was expended by the United States.

A second project (H. Doc. No. 23, 52d Cong., 1st sess.) was adopted July 13, 1892, on recommendation of the Board of Engineers convened in compliance with the act of September 19, 1890. This project was modified March 2, 1899, and as modified it provided for maintenance and the construction of new dikes for regulating the channel between Coxsackie and New Baltimore and for deepening the river so as to afford a channel 12 feet deep at mean low water from Coxsackie to the State dam at Troy; the widths of channel to be 400 feet from Coxsackie to Broadway, Troy, thence decreasing to 150 feet at Jacob Street, thence remaining 150 feet to the State dam. Though not so reported, this project was practically completed in 1910, and work under it was abandoned; the balance of funds on hand was applied to work under the existing project. For history of the improvement of this river see Annual Report for 1885 (p. 677 et seq.);

Digitized by Google

for report of the board which formulated the second project see Annual Report for 1892 (p. 750 et seq.).

The sum of $5,466,752.32 was expended by the United States in the work under the original and second projects, including the authorized expenditure of $38,432.37 at Stonehouse Bar, Tarrytown Harbor, and Schodack Creek, not considered in the original estimates.

The improvement under the projects of 1834 and 1892 resulted in securing by 1910 a channel from the State dam at Troy to Coxsackie of the maximum available depths at mean low water[1] and minimum available widths, as shown by the following table:

Locality.	Width.	Depth.	Locality.	Width.	Depth.
	Feet.	*Feet.*		*Feet.*	*Feet.*
Coxsackie Shoal	600	12.0	Bath Crossover	300	11.5
Bronk Island Shoal	50	12.0	Bath Shoal	200	12.0
Stonehouse Bar	200	11.5	Kellogg Shoal	170	12.0
Willow Island Shoal	400	12.0	Fishhouse Shoal	230	12.0
New Baltimore Bar	400	12.0	Round Shoal	130	11.0
Coeymans Crossover	50	12.0	Covills Folly	100	12.0
Roah Hook to North Coeymans	100	10.5	Breaker Island	220	12.0
Mulls Crossover	200	12.0	Van Buren Bar	90	12.0
Nine Mile Tree Crossover	200	11.5	Washington Bar	170	12.0
Castleton Bar	200	11.5	Front of Watervliet Arsenal	200	12.0
Cedar Hill Bar	60	11.5	Arsenal to Congress Street, Troy, N. Y.	300	12.0
Winnies Bar	270	12.0	Congress Street Bridge		
Stone Light Shoal	320	11.5	East draw	80	12.0
Beacon Island Shoal	500	12.0	East fixed span	150	12.0
Bogart Light Shoal	200	12.0	Congress Street to Broadway	200	12.0
Douws Point Crossover	200	11.5	Broadway to Delaware & Hudson bridge	100	12.0
Cuyler Bar	300	12.0	Delaware & Hudson bridge:		
Passenger bridge:			Draw span	45	11.0
East draw	100	10.0	East fixed span	50	12.0
West draw	100	12.0	Hoosick Street	100	11.0
West fixed span	160	12.0	Hoosick Street to Boutwells	100	12.0
Freight bridge:			Boutwells to Middleburgh Street	75	8.5
West draw	90	12.0			
East draw	90	11.5			
East fixed span	75	11.5			

15. SAUGERTIES HARBOR, N. Y.

The original project was adopted by the river and harbor act of July 5, 1884, and modified in 1887. As modified, it provided for the securing of a permanent channel 7 feet deep at mean low water and 100 feet wide from the creek to deep water in the Hudson River, a distance of about three-quarters of a mile, by the construction of two parallel dikes, each 2,300 feet long, 260 feet apart on the inside and 280 feet apart on the outside, and by dredging, if found necessary, 30,000 cubic yards of material at an estimated cost of $52,000. It was completed in 1892 at an expenditure of $42,000. As completed it resulted in the construction of two parallel dikes of 2,058 feet and 2,363 feet, respectively, with a waterway between them 260 feet wide, and the navigable channel deepened by dredging for a width of 150 feet.

19. HUDSON RIVER CHANNEL, NEW YORK HARBOR.

The first project for improvement of the Hudson River within the section included in the present project was adopted March 3, 1875, and is based upon a report, with estimate of cost, submitted February

[1] This plane of mean low water is 3.1 feet higher at Troy, and 2.5 feet at Albany and south from Albany, than the plane of lowest water assumed for project of 1910.

Digitized by Google

1, 1875 (H. Doc. No. 158, 43d Cong., 2d sess., without map, and Annual Report for 1875, p. 216, without map). It provided for dredging a shoal to a depth of 25 feet at mean low water from the neighborhood of Pavonia Ferry to a short distance below the Cunard docks, over an area of 223,500 square yards. Estimated cost, $101,807.20.

In 1876 there was removed from this shoal 163,639 cubic yards of material, and in 1877 (Annual Report for 1877, p. 245) an examination and survey showed that about 100,000 cubic yards of material had been washed into the dredged area, leaving nearly the same depth of water as existed before the dredging was done. Under date of April 5, 1877 (Annual Report for 1877, p. 246), it was recommended that no further work be done under this project. The amount expended was $25,000.

There being no funds available and no project for the improvement of the Hudson (North) River, in the section situated between the city of New York and Jersey City, N. J., the sum of $25,000 was authorized by joint resolution of July 1, 1902, to be diverted from the appropriations theretofore made for the improvement of Ambrose Channel, New York Harbor, for the removal of a rock or obstruction near Pier A, North River. The river and harbor act of March 3, 1905, authorized an additional sum, not to exceed $20,000, to be diverted for the same purpose. The rock was reported removed to a depth of 40 feet at mean low water in December, 1909 (Annual Report 1910, p. 1216). The cost of this work was $41,479.12. Subsequent examination showed that an extension of this rock had but 38 feet of water over it at mean low water. The removal of this part of the rock to a depth of 40 feet is provided for in the existing project.

Further details are published in the Annual Report of the Chief of Engineers for 1882 (no map), page 719, part 1; 1884 (no map), page 774; and 1885 (contains map), page 791.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE SECOND NEW YORK, N. Y., DISTRICT.

---

1. NEW YORK HARBOR, N. Y.

The first appropriation for New York Harbor was one of $200,000 made by the river and harbor act of July 5, 1884, for "deepening Gedneys Channel through Sandy Hook Bar." It was not made in reference to any recommendation of the Engineer Department, nor upon any estimate of cost, and it provided no specific depth or width. It was regarded as an experiment, to ascertain whether the channel could be deepened without contraction by breakwaters. It was more successful than had been anticipated and by the river and harbor act of August 5, 1886, Congress appropriated $750,000 "to secure a 30-foot channel at mean low water at the Sandy Hook entrance of the harbor, upon such plan as the Secretary of War may approve." The Secretary of War approved, on December 27, 1886, a plan for "secur-

Digitized by Google

ing a permanent low-water channel 30 feet deep from the deep water of New York Harbor to the deep water of the Atlantic by way of Sandy Hook," estimated to cost $1,490,000. (Annual Report for 1887, pt. 1, p. 62.) In the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1888, part 1, page 63, the width of channel so approved is stated as 1,000 feet.

These are the first published reports describing the limits of the project, which was completed under subsequent appropriations in October, 1891. This channel was maintained to its full depth and, as nearly as possible, to its full width, with increased width at the bend. Since Ambrose Channel was opened to navigation by vessels under their own motive power, the old channel has decreased in importance, and is now maintained to its full depth, but not necessarily to full width, for use by sailing vessels and tows which are excluded from Ambrose Channel.

A joint resolution of Congress approved January 12, 1899 (public resolution No. 7), directed the Secretary of War—

to submit a report of survey and estimate for the improvement of the east channel in New York Harbor from the Narrows to the sea and for the enlarging of the same to the depth of 35 feet and a width of 1,500 feet, and also to report upon the desirability of such improvement.

This report was submitted and printed as House Document No. 159, Fifty-fifth Congress, third session, and contained estimates by the Board of Engineers already prepared for a channel 2,000 feet wide and 35 feet deep, and expressing the opinion that the channel should ultimately be made 40 feet deep, at estimated cost of $6,688,000. This report was accepted by Conugress as sufficiently meeting the requirement, and on March 3, 1899, an appropriation was made for improving New York Harbor—

by a deep channel 2,000 feet wide and 40 feet deep from the Narrows by the so-called East Channel, across Sandy Hook Bar to the open sea, in accordance with the recommendation contained in House Document No. 159, Fifty-fifth Congress, third session, $1,000,000: *Provided*, That the Secretary of War may forthwith enter into a contract or contracts for such materials and work as may be necessary for the completion of said project, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate $3,000,000, exclusive of the amount herein and heretofore appropriated.

If, however, the Secretary of War shall be unable to make a contract or contracts for the completion of said project for a sum within the amounts above specified, then the said $1,000,000 herein appropriated, or so much thereof as may be necessary, shall be applied by him in the construction or purchase of such dredges, steamboats and other plant, machinery, and appliances as may be necessary to prosecute said project, and shall cause the work on said project to be entered upon and prosecuted under the charge of the Secretary of War by employment of labor and materials necessary therefor, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate the said sum of $3,000,000, exclusive of the $1,000,000 herein appropriated.

This limit of authorized expenditures, $4,000,000, was increased to $5,148,510, by act of Congress of March 2, 1907. Joint resolution of Congress July 1, 1902, and the river and harbor act of March 3, 1905, authorized the diversion of $45,000 from appropriation for Ambrose Channel, to be applied to the removal of a submerged reef in the North River, near Pier A. The reef was removed to 40 feet depth in December, 1909, at net cost of $41,479.12, and the balance of the $45,000 reverted to Ambrose Channel funds.

Digitized by Google

2. NEW YORK HARBOR; CONEY ISLAND CHANNEL.

The first work done in this channel was August to November, 1900. Dredging was done near the west end of the channel to remove part of a shoal called the "Lewis," it being traditional that a tug of that name sunk in the vicinity many years ago and caused the formation of the shoal. This work was done from funds appropriated for maintenance of entrance channels in New York Harbor, under authority of the Chief of Engineers dated July 31, 1900. Under agreement with the R. G. Packard Co., 38,460 cubic yards of sand were excavated, at 24 cents a cubic yard, and the channel was straightened and made 14 feet deep for widths of 500 to 550 feet. (Annual Report for 1900, pt. 1, p. 1287.) Under an allotment of $8,000 from the appropriation of April 28, 1904, for emergencies of rivers and harbors, 21,649 cubic yards of sand were dredged from the west end of this channel to restore the 14-foot depth for a width of 400 feet. The work was done June-August, 1905, under contract with the W. H. Beard Dredging Co., at a price of 36 cents per cubic yard. (Annual Report for 1906, pt. 1, p. 970.) The total expenditures on account of the above work amounted to $17,230.40.

3. NEW YORK HARBOR; BAY RIDGE AND RED HOOK CHANNELS.

The first project for improving Bay Ridge and Red Hook Channels was adopted by the river and harbor act of March 3, 1881, and was based upon a report and survey ordered by act of Congress of June 14, 1880. (Annual Report for 1881, p. 635.) The project provided for dredging a channel 18 feet deep at mean low water and 200 feet wide, from Hamilton Avenue Bridge to the 18-foot contour in the bay, the upper 400 feet of its length narrowing to 100 feet in width; length, 9,000 feet; estimated cost, $182,850. The project was revised (Annual Report for 1885, pp. 93 and 672) to provide for a fork near the outer end, one branch extending northwardly to Erie Basin entrance, the other southwestwardly to the 18-foot contour opposite Forty-eighth Street, at total estimated cost of $192,564.90.

In 1887 this channel, then about half completed, was already regarded as insufficient, and an estimate of $600,000 was submitted for a channel 21 feet deep and 400 feet wide (Annual Report for 1888, p. 613). The river and harbor act of August 11, 1888, modified the project of 1881, and provided for deepening Red Hook Channel to 21 feet and widening it to 400 feet from Percival Street to the 23-foot curve opposite Erie Basin entrance. This increased depth was extended to include Bay Ridge Channel, under the specific terms of the river and harbor act of September 19, 1890, which appropriated $100,000 for a channel 400 feet wide and 21 feet deep on the south shore, from Twenty-eighth Street south along that shore to the 21-foot curve near Bay Ridge. This project was completed in July, 1895, at an expenditure of $410,100.

A second project was adopted by the specific terms of the river and harbor act of August 18, 1894, providing in detail for continuing the improvement of Bay Ridge Channel from its junction with Gowanus Creek Channel near Twenty-eighth Street to the 26-foot contour, making it 800 feet wide and 26 feet deep, and continuing the improvement of Red Hook Channel from its junction with Bay Ridge Channel to its connection with Buttermilk Channel, making

Digitized by Google

it 400 feet wide and 26 feet deep. This project was based upon surveys of the two localities ordered by act of Congress of September 19, 1890 (H. Ex. Docs. Nos. 26 and 60, 51st Cong., 2d sess.). The estimated cost was $633,300. The project also included an expenditure of $20,000 for 21 feet depth and 250 feet width in Gowanus Creek, which was not so applied because the channel was already 21 feet deep. Up to June 30, 1896, $564,939.14 had been expended upon this project. By the terms of the river and harbor act of June 3, 1896, this project was modified to add Buttermilk Channel to the project and to include a certain triangular area at the bend where Red Hook Channel joins Bay Ridge Channel; all to be made 26 feet deep and with "width as recommended for each." This provided for a width of 800 feet in Bay Ridge Channel, 400 feet in Red Hook Channel, a maximum width of 900 feet in triangular area, and 1,000 feet width in Buttermilk Channel. The act also provided for expenditure of $5,000 in dredging Gowanus Canal from Percival Street to Hamilton Avenue Bridge, dimensions not specified, and authorized a continuing contract at not to exceed the sum of $637,000 in addition to $200,000 cash appropriation. This project was completed June 24, 1899. Gowanus Canal was dredged from Percival Street to 50 feet below the Hamilton Avenue Bridge, making it 18 feet deep with width of 155 feet at Percival Street, narrowing to 55 feet at the upper end. The other channels were made the full dimensions named in the project. The total amount expended on the second project was $667,920.05.

6. NEWTOWN CREEK, N. Y.

In 1857 the depth at mean low water in Newtown Creek, near its mouth, was about 17 feet, but in 1879, prior to the adoption of the original project for improvement, it had shoaled to about 12.5 feet. This shoaling, and for a number of years subsequent to the time that the improvement of this waterway was undertaken by the United States, was very largely due to the subsidence of the meadow lands which bordered the creek for considerable areas toward the head of navigation.

The original project for improvement, which was adopted by the river and harbor act of June 14, 1880, and was modified in 1884, provided for dredging of a channel 18 to 21 feet deep at mean low water, and 200 feet wide, extending from East River to the Vernon Avenue Bridge at an estimated cost of $36,250. In 1881 a channel 18 feet deep at mean low water and 60 feet wide was dredged for the project length and it was recommended that the estimated cost be increased to $46,000. In 1883 the channel width was increased by dredging to 150 feet for 1,200 feet and to 75 feet for an additional 1,100 feet. The river and harbor act of July 5, 1884, provided for continuing the improvement to provide the following dimensions:

Section.	Depth (at mean low water).	Width.
	Feet.	*Feet.*
Vernon Avenue Bridge to Central Oil Works	18	175
Central Oil Works to Queens County Oil Works	15	150 to 125
Queens County Oil Works to Nichols Chemical Works	12	150 to 125
Nichols Chemical Works to head of navigation on both branches	10	100 to 125

Digitized by Google

The estimated cost was $230,569. In 1889 a revised estimate of cost of $170,586.30 was submitted. (See Annual Report for 1889, p. 778.) In 1891 a channel 10 feet deep at mean low water and 100 feet wide was dredged for a distance of 700 feet eastwardly from the Nichols Chemical Works in the English Kills branch (now Maspeth Creek). In 1894 an examination was made with a view to extending the improvement in the east branch from the Metropolitan Avenue Bridge to Montrose Avenue, but was reported adversely. (H. Ex. Doc. No. 32, 53d Cong., 3d sess.) In 1895 about 150 tons of boulders were removed from the mouth of the creek by the United States drill scow *Hudson*. The condition of the improvement on June 30, 1896, was reported as follows. (See Annual Report for 1896, p. 761.)

The channel has been dredged to depths and widths as follows:

	Width.	Depth.
	Feet.	*Feet.*
Entrance to Vernon Avenue Bridge	150–175	18
	40	21
Thence to Central Oil Works	80	16
	40	18
Thence to Queens County Oil Works	100	14
Thence to Nichols Chemical Works	75	10
Thence to Maspeth Avenue	50	10
Thence to Metropolitan Avenue:		
East branch	100	10
West branch	50	10
English Kills (now called Maspeth Creek), channel 700 feet long	100	8

Under the previous and modified projects a total of about 694,393 cubic yards of material was removed and $197,500 was expended. These amounts included both original work and maintenance, no separate accounts having been kept.

7. JAMAICA BAY, N. Y.

The only previous project for improving Jamaica Bay contemplated an improvement of only that part of the bay leading to the Canarsie landings, and was carried on under title of "Improving Canarsie Bay, N. Y." It was adopted by the river and harbor act of 1880, and contemplated dredging a channel 100 to 150 feet wide and 6 feet deep to connect the Canarsie landings with Big Channel, Jamaica Bay, and building dikes on either side of the dredged channel. The project was enlarged in 1889 and again in 1896 to provide for its extension along the Canarsie water front 1,800 feet southwestwardly to Island Channel, with 50 feet width and 4 feet depth, and 1,200 northeastwardly to Gophel Channel, 50 feet wide and 5 feet depth. The estimated cost was $88,000. Up to June 30, 1912, $69,872.36 had been expended upon original work and $2,961.45 upon maintenance, a total of $72,833.81. The channels had been dredged to the required depth and nearly to the required width and the two dikes had been built. The channels shoaled so rapidly that it was impracticable to maintain them continuously at any moderate cost; the dikes had deteriorated. In 1912, when work was begun upon the general project for improving Jamaica Bay, which included the approaches to Canarsie, the improvement of Canarsie Bay as a separate work was abandoned.

Digitized by Google

8. SHEEPSHEAD BAY, N. Y.

The initial project for the improvement of Sheepshead Bay was adopted by the river and harbor act of June 14, 1880, at an estimated cost of $100,000 (H. Ex. Doc. No. 89, 45th Cong., 3d sess.). The project contemplated the construction of creosoted-timber dikes to confine and direct the flow of water in such a way as to create reservoirs and cause a scour sufficient to maintain a channel 6 feet deep at mean low water. On account of the shifting of sand at the entrance and the westward progression of Rockaway Point, it was believed to be advisable to delay the prosecution of the improvement. In 1882 the plan was changed to provide for dredging a channel 100 feet wide and 6 feet deep at mean low water connecting Sheepshead Bay and Dead Horse Inlet and for an interior channel from the village of Sheepshead Bay eastward to connect with the Dead Horse Inlet connection, at an estimated cost of $34,200.

In 1883, 1885, and 1886 dredging operations were carried on and a channel 1,600 feet long, about 100 feet wide and 4 feet deep at mean low water, connecting Sheepshead Bay and Dead Horse Inlet was obtained. In 1889 an interior channel 60 feet wide and 5.5 feet deep at mean low water was dredged from the village of Sheepshead Bay eastward for a distance of 3,400 feet. Under the original project a total of 68,281 cubic yards was removed and $26,000 was expended. In 1898 a storm broke through the eastern end of Coney Island, Manhattan Beach, at a point about opposite the mouth of Hog Creek. Under these same storm conditions the sand was shifted northeast and the channel in that section closed and partially obliterated. The present inlet to Sheepshead Bay was the result.

9. HARBORS AT PORT JEFFERSON, MATTITUCK, HUNTINGTON, AND FLUSHING BAY, N. Y.

(A) PORT JEFFERSON, N. Y.

The first appropriation for Port Jefferson Harbor was $15,000, made by the river and harbor act of March 3, 1871 (H. Ex. Doc. No. 60, 41st Cong., 3d sess.). The improvement contemplated was the construction of an east breakwater, about 800 feet in length, to arrest the westward movement of the sand and gravel, which formed the spit on the east side of the entrance to the harbor with the idea that the tidal flow would be strengthened and that its velocity and force would be sufficient to scour a channel and to maintain it to the projected depth of 7 feet at mean low water. The estimated cost was $175,000. In 1875 the plan was modified in accordance with the report of the district officer to include a west jetty to assist in directing the tidal flow. The west jetty was started in 1876. In 1877 the district officer recommended the extension of the east breakwater to the 9-foot curve and that the dimensions of the channel be increased to 8 feet in depth at mean low water and 200 feet in width, at an estimated cost of $34,000.

The construction of the east jetty was commenced in May, 1872, and in June, 1873, it had been built to a length of 1,052 feet. The effect was marked, but the assistance of a west jetty and dredging through the bar were considered advisable. In 1883 the east jetty

Digitized by Google

had been extended to a length of 1,390 feet with a depth of 10 feet at low water at its outer end, and the west jetty had been extended to a length of 940 feet with 6.5 feet of water at its outer end. Up to this time 26,131 tons of stone had been placed in the two structures. Old reports are not specific, but it is estimated that 16,000 tons were placed in the east and 10,131 in the west jetty.

Under these projects comparatively little dredging was done, a total of 8,165 cubic yards having been removed, but the scour maintained a channel approximately 100 feet wide and 8 feet deep at mean low water. The total amount appropriated for this project was $79,000.

(*c*) HUNTINGTON HARBOR, N. Y.

Prior to the improvement of Huntington Harbor by the United States a broad expanse of mud flats existed in front of the wharves near the head of navigation and extended northwardly for about 3,000 feet, but from this point to the inlet, a distance of about 7,500 feet, a channel 8 feet deep at mean low water existed. The entrance was obstructed by a few bowlders and a bar with a depth of about 3 feet at mean low water. Such commerce as existed was carried on at high water. The improvement contemplated the removal of the bar at the entrance and provision for a dredged channel 8 feet deep at mean low water with a width of 150 feet, extending from the 8-foot contour in Huntington Harbor, near Ketcham's Dock, to the old Town Dock, a distance of about 2,200 feet. The head of navigation was at the causeway, about one-third of a mile south of the old Town Dock.

The initial project was adopted by the river and harbor act of June 10, 1872, at an estimated cost of $22,500 (S. Ex. Doc. No. 23, 42d Cong., 2d sess.). The first work of improvement was begun in 1872 and the work completed in 1873. The entrance channel was dredged to a depth of 8 feet at mean low water for a width of 130 feet, and a channel 8 feet deep at mean low water and 150 feet wide for a distance of 1,300 feet and 130 feet wide for an additional 900 feet was dredged through the mud flats to the old Town Dock. A total of 91,786 cubic yards of material was removed and $22,299.46 was expended on the project.

(*d*) FLUSHING BAY, N. Y.

Prior to the improvement of Flushing Bay by the United States a channel about 9 feet deep at mean low water with widths varying from 100 to 600 feet extended for a distance of about 2,000 feet from deep water in East River. Throughout the remainder of the bay up to the mouth of Flushing Creek a more or less uniform depth of from 4 to 5 feet at mean low water existed. The depths at mean low water in Flushing Creek varied from 0 to 21 feet and the widths varied from 40 to 300 feet. The insufficient depths over the larger portion of the bay greatly restricted navigation.

The initial project contemplated the construction of a dike system on the west side of the channel so as to form a tidal basin, the outlet of which would be through the projected channel, which was to be dredged to a depth of 6 feet at mean low water. The flow of water

Digitized by Google

from the tidal basin was to be further guided by a dike to be constructed on the east side of Flushing Bay. It was expected that the force of the tidal flow, with the assistance of a moderate amount of dredging, would be sufficient to scour out and maintain a channel 6 feet deep at mean low water. The initial project was adopted by the river and harbor act of March 3, 1879, at an estimated cost of $173,500 and provided for the dredging of 83,000 cubic yards (more or less) of material and the construction of 16,700 linear feet of dike.

The construction of the dike was begun in February, 1880, and 3,057 linear feet were built along the west side of the channel, beginning at a point about 900 feet from the head of the bay. By June 24, 1881, a channel 6,000 feet long, 65 feet wide, and 6 feet deep at mean low water had been dredged. In 1883 a spur channel 1,500 feet long, 80 feet wide, and 6 feet deep at mean low water was dredged from a point on the main channel near the south end of the dike westwardly to Hill's Dock. Dredging operations were continued and the channel was increased in width from time to time, but considerable local opposition to the construction of the cross dike to form the tidal basin and the training dike on the east side developed, and in 1888 the project was modified so that the construction of these two sections was omitted and the extension of the dike already constructed was provided for. (See Annual Report for 1889, p. 730.) The existing dike was extended to a length of 4,663 feet in 1889, but such vigorous protest was entered against any further dike construction that the project was again modified in 1891, discontinuing that feature of the improvement. (See Annual Report for 1892, p. 723.) In 1907 the project was modified for the third time and the dredging of a channel 6 feet deep at mean low water, 200 feet wide, extending from the 6-foot contour in the bay to the Broadway Bridge, thence 100 feet wide to the Main Street Bridge of the Long Island Railroad, was provided for. By the close of the fiscal year 1909 the project had been completed except for the removal of a small shoal just north of the Broadway Bridge. Under the original and modified projects a total of 531,022 cubic yards of material was removed prior to June 30, 1912. Prior to July 1, 1915, a total of $178,914.20 had been expended on the original project and its modifications, of which amount it is estimated that $148,666.74 was for new work and $30,247.46 was for maintenance.

11. GREAT SOUTH BAY, N. Y.

Prior to the improvement of Patchogue River by the United States its mouth was obstructed by a bar with a depth of 1.5 feet at mean low water, mean range of tide about 1 foot. Not only was freight traffic practically impossible, but the oyster and fishing fleet was frequently compelled to weather storms and ice in the open bay. The improvement contemplated the relief of such conditions by a dredged channel 60 feet wide and 6 feet deep at mean low water from the 6-foot contour in Great South Bay to the head of navigation, at Division Street, in the village of Patchogue, and a stone jetty or breakwater 1,700 feet long on the west side to protect the mouth of the river. The initial project was adopted by the river and harbor act of September 19, 1890, at an estimated cost of $40,000. (Annual Report for 1887, p. 759.)

Digitized by Google

The first work of improvement was the construction of the jetty, which was begun in 1890, and in 1891 was completed for a length of 1,340 feet, terminating in 4.5 feet of water. In 1897 the jetty was extended to the projected length of 1,700 feet, about 6,400 tons of stone having been placed in the structure. It was of scant cross section, having a top width of 3 feet and an elevation of two feet above high water. The first dredging was begun in 1891, and operations were carried on under various contracts until a channel 6 feet deep and 60 feet wide, with a turning basin 100 feet wide at the head of navigation, was secured in 1897.

In 1893 the width at the entrance was increased to 85 feet by dredging off a point on the east side at the mouth of the river, and private parties had a small channel dredged east of the one dredged by the United States. In the same year the middle ground between these two channels was removed, which resulted in increasing the width of the channel to about 150 feet and made a small area available for anchorage purposes. Under the original project a total of 84,172 cubic yards of material was removed, of which about 16,000 cubic yards was chargeable to maintenance. A total of $40,000 was expended.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE THIRD NEW YORK, N. Y., DISTRICT.

---

1. NEWARK BAY AND PASSAIC RIVER, N. J.

On August 30, 1852, $10,000 was appropriated by Congress for the improvement of Newark Bay, and $2,000 was appropriated for the survey of same. The survey was made and report rendered under date of January 27, 1853. There is no record in this office that shows whether work of improvement was done, or what disposition was made of the funds.

The first project for the improvement of Passaic River was adopted by the river and harbor act approved June 10, 1872 (with subsequent modifications), and now exists in part. It provides for making a channel by dredging and diking from the Center Street Bridge, Newark, to the highway bridge at Passaic, which is about 3½ miles below the Dundee Dam. The length of the channel is about 8½ miles. The width to be made was from 50 to 200 feet, and the depth 6 to 7½ feet at mean low water. The mean range of tides at the Montclair & Greenwood Lake Railroad bridge is 5 feet, and at Passaic 4.6 feet. The original estimate of the cost was $123,924. This was subsequently increased in 1890 to $193,822. (See S. Doc. No. 35, 42d Cong., 2d sess., and Annual Report for 1872, p. 807.)

The second project, now covered by a third project, was adopted by the river and harbor act approved June 14, 1880, for improving the Passaic River from the Center Street Bridge to project depth in Newark Bay, about 5 miles in distance. It provided for making a channel 200 feet wide and 10 feet deep at mean low water by diking and dredging. The mean range of tides in this section of the river is 5 feet. The original estimated cost was $353,875. (See Annual Report for 1880, p. 537.)

Digitized by Google

The first two projects were consolidated by the river and harbor act of July 13, 1892; the estimated cost of the improvement was revised to $547,697. (See Annual Report for 1893, p. 1108.)

The third project was adopted by the river and harbor act approved June 13, 1902. It provides for making a channel by dredging and diking from Staten Island Sound through Newark Bay and the Passaic River to the Montclair & Greenwood Lake Railroad bridge 200 feet in width and 12 feet deep at mean low water to the Nairn linoleum works, thence 10 feet deep to the said railroad bridge, a distance of 10.8 miles. The mean range of tides is 5 feet. The estimated original cost was $296,000, annual maintenance $5,000. This was subsequently increased to $323,274.60, annual maintenance $10,000, additional funds having been appropriated by the river and harbor act of March 3, 1905. (See H. Doc. No. 401, 56th Cong., 1st sess., and Annual Report for 1900, p. 1530.)

The fourth project was adopted by the river and harbor act approved March 2, 1907, and it provides for making a channel by dredging 16 feet deep at mean low water, 300 feet wide from deep water in Newark Bay to the Nairn linoleum works, 9.7 miles, thence 200 feet wide to the Montclair & Greenwood Lake Railroad bridge, 1.1 miles. The mean range of tides is 5 feet. It was estimated to cost $1,216,775; annual maintenance, $10,000. (See H. Doc. No. 441, 59th Cong., 2d sess., and Annual Report for 1907, p. 175.)

The river and harbor act of February 27, 1911, provided that the project for improvement below said bridge may, in the discretion of the Secretary of War, be so modified as to allow the widening of the channel at the bends where considered desirable in the interests of commerce and navigation; also that the cost of the project shall not be increased by such additional work beyond that stated in House Document No. 441, Fifty-ninth Congress, second session.

The fifth project was adopted by the river and harbor act approved July 25, 1912. It provides for increasing the depth by dredging in Newark Bay and Passaic River to 20 feet at mean low water, and 300 feet wide to the Nairn linoleum works, about 10.3 miles; thence 16 feet deep and 200 feet wide to the Montclair & Greenwood Lake Railroad bridge, 1.1 miles, in accordance with the provisions of the project of 1907. The mean range of tides is 5 feet. The estimated cost of the project is $1,064,800, with an annual maintenance cost of $20,000. (See H. Doc. No. 707, 62d Cong., 2d sess., and Annual Report for 1912, p. 279.)

Further details as to this improvement may be found in the Annual Reports of the Chief of Engineers for 1896, pages 770 to 774, and for 1900, pages 177 and 1530 to 1550.

3. ARTHUR KILL, OR STATEN ISLAND SOUND, N. Y. AND N. J., AND CHANNEL NORTH OF SHOOTERS ISLAND, BETWEEN NEW YORK AND NEW JERSEY.

The first project, under title of "Channel between Staten Island and New Jersey," was adopted under authority of the river and harbor act of June 23, 1874. It provides for making and maintaining a channel by diking and dredging through a stretch of about 1¾ miles where the waters of Newark Bay join those of the Kills, the channel to be 150 feet wide and 16 feet deep at mean low water. The channel

Digitized by Google

is to take a course north of Shooters Island. The mean range of tides is about 5 feet. The estimated original cost of the improvement was $443,210. Under the project 2,237 linear feet of dike were built. (See Annual Report for 1873, p. 943, and S. Doc. No. 52, 42d Cong., 3d sess.)

According to the act of March 3, 1875, a board was appointed by the Secretary of War with authority to modify the original plan of improvement. A modification was made providing for a width of about 500 feet and depth of 11 feet by dredging. The channel was to follow the general lines of the original channel south of Shooters Island. The estimated cost was $40,480. No work was done under the modification. (See Annual Report for 1876, p. 252.)

The second project, under title of "Channel between Staten Island and New Jersey," was adopted by the act of June 14, 1880. It provided for making and maintaining a channel by diking and dredging along the route of original natural channel south of Shooters Island, over the flats at the base of Newark Bay, the length to be about 1¾ miles, width to be 400 feet; the center 200 feet of channel to have a depth of 13 feet at mean low water; the remaining widths of the channel to be made 12 feet deep. The mean range of tides is about 5 feet. The estimated original cost was $185,705. (See Annual Report for 1881, p. 693.)

The project was modified in 1883 on recommendation of the Chief of Engineers (Annual Report for 1883, p. 575). The modification provided for making 13 feet depth over the full width of 400 feet. The estimated cost was $210,000, of which $60,000 was for dikes.

The project was further modified by act of May 15, 1889, when the dikes as proposed under the project were abandoned. No work was done on them under this project.

The project was again modified by the act of October 20, 1890, when the depth was increased to 14 feet at mean low water.

By the river and harbor acts of June 3, 1896, and June 13, 1902, the project was further extended to include the dredging of a channel in Lemon Creek, Staten Island, at a cost of $5,000 and $5,000, respectively. This was to provide for dredging a channel 8 feet deep at mean high water and 50 feet wide from deep water in Princess Bay to the drawbridge; thence 35 feet wide as far up as the appropriations would carry. Under this project the channel dimensions as projected and modified have been completed. No dikes were built. Work for maintenance was done.

The third project, under title of "Improving Arthur Kill, New York and New Jersey," was adopted by the river and harbor act of August 11, 1888. This project was in a degree supplemental to the project of 1880. It provided for the straightening of and dredging the channel in the vicinity of the Baltimore & Ohio Railroad bridge at Elizabethport, and removing a point of land westerly of same known as Steep Point. The estimated cost of this improvement was $26,500. The project was completed January 24, 1895, at a cost of $25,407.23. (See S. Doc. No. 17, 49th Cong., 2d sess., and Annual Report for 1887, p. 2632.)

The fourth project was adopted by the river and harbor act of June 13, 1902. It provided for making and maintaining a channel from Kill von Kull to Raritan Bay, a distance of about 14 miles, by means of dredging and diking 300 feet wide and 21 feet deep at mean

Digitized by Google

low water. Mean range of tides is about 5 feet. The estimated cost was $696,000 and $5,000 annual cost for maintenance, which was subsequently increased to $25,000. (See H. Doc. No. 337, 59th Cong., 2d sess.) The project has been completed. Work for maintenance has been done. No dikes have been built. (See H. Doc. No. 393, 56th Cong., 1st sess., and Annual Report for 1900, p. 1525.)

The fifth project, under title of "Channel north of Shooters Island between New York and New Jersey," was adopted by the river and harbor act approved June 25, 1910. It is an extension of the project of 1902, and provides for a channel about 1 mile in length connecting the main channel of Arthur Kill at the Corner Stake Light with Newark Bay, lying north of Shooters Island, the channel to be 300 feet wide and 16 feet deep at mean low water. This project also included the removal of a middle ground in the main channel of Newark Bay, northeast of Shooters Island between Bergen Point and Shooters Island; the removal of a part of Bergen Point Reef, and a middle ground at Corner Stake Light, the depth to be 16 feet at mean low water. The main range of tides is about 5 feet. The estimated cost was $280,115, with $5,000 annually for maintenance. (See H. Doc. No. 337, 59th Cong., 2d sess., and Annual Report for 1907, p. 175.)

The sixth project was adopted by the river and harbor act of March 4, 1913. It provides for securing a channel 25 feet deep at mean low water and a width of 400 feet by dredging and rock removal from Perth Amboy to east end of Shooters Island joining Kill van Kull, with a suitable turning basin of the same depth at the mouth of Fresh Kills. Estimated cost $2,130,000, and $50,000 annually for maintenance. (See H. Doc. No. 337, 59th Cong., 2d sess.)

Detailed descriptions of this waterway and the projects for its improvement are printed in the Annual Report of the Chief of Engineers for 1900, pages 178 and 1525 to 1530; in House Document No. 1124, Sixty-second Congress, third session, and House Document No. 337, Fifty-ninth Congress, second session.

4. WOODBRIDGE CREEK, N. J.

The original project was adopted by the river and harbor act of March 3, 1879. It provided for dredging a channel 12 feet deep at mean high water and 80 feet wide from the mouth of the creek to Salamander Dock, 1.8 miles distant, and the building of about 500 feet of pile dike in the vicinity of Town Dock. The mean range of tides is about 5 feet. The estimated cost of the improvement was $13,800, which amount was increased in 1884 to $29,000. The project was suspended in 1883. (See Annual Report for 1879, p. 478.)

6. KEYPORT HARBOR, MATAWAN CREEK, RARITAN, SOUTH AND ELIZABETH RIVERS, SHOAL HARBOR AND COMPTON CREEK, AND CHEESEQUAKE CREEK, N. J.

(c) RARITAN RIVER, N. J.

A survey of the Raritan River for the improvement of New Brunswick Harbor was made in 1836, and in the following year $13,963 was appropriated for this work, but the records of this office do not show what work was done.

Digitized by Google

(D) SOUTH RIVER, N. J.

The first project for this improvement was adopted by the river and harbor act of March 3, 1871. The project provided for dredging a channel 6 feet deep at mean low water up to the Washington wharves, a distance of about 1½ miles. The width to be made was indefinite, but the survey on which the improvement was based recommended the original width of 80 feet, as made when the Washington Canal was dug about 40 years prior to this time by the New Jersey Transportation Co. The mean range of tides is about 5.34 feet. This improvement was completed in 1874. Amount expended on improvement $20,000. (See H. Doc. No. 60, 41st Cong., 3d sess., and Annual Report for 1871, p. 698.)

(E) ELIZABETH RIVER, N. J.

The original project was adopted March 3, 1879. It consisted in dredging a channel 60 feet wide and 7 feet deep at mean high water to Broad Street, Elizabeth, a distance of about 2¾ miles. The mean range of tides at the mouth is 4.7 feet, and at Bridge Street, Elizabeth, 3.4 feet. The original estimate of cost was $25,530. This was revised in 1881 to $43,160. This project was completed in 1897, and it was dropped from the list of works June 30, 1911, the upper part of the river having fallen into disuse as a navigable stream, and was used as a sewer outlet by the city of Elizabeth. (See Annual Report for 1870, p. 481.)

For details of the improvement see Annual Report of the Chief of Engineers for 1897, page 1134.

7. SHREWSBURY RIVER, N. J.

By act of Congress of August 30, 1852, $1,500 was appropriated and expended upon a survey to ascertain the extent of a break through the beach between Shrewsbury River and the ocean, but no work of improvement was begun.

The first project was adopted by the river and harbor act of March 3, 1871. It provided for dredging a 6-foot channel through a bar opposite and four bars above the Navesink Lights. The estimated cost of this improvement was $14,000. The work was done as proposed and a bar near Lower Rocky Point was removed. The work was completed in 1873 at a cost of $19,000. (See H. Doc. No. 60, 41st Cong., 3d sess., and Annual Report for 1871, p. 702.)

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE PHILADELPHIA, PA., DISTRICT.

---

3. DELAWARE RIVER, PA. AND N. J., PHILADELPHIA, PA., TO TRENTON, N. J.

Prior to the adoption by the river and harbor act of June 25, 1910, of the project for a channel 200 feet wide and 12 feet deep from Allegheny Avenue, Philadelphia, to Trenton, N. J., efforts were directed toward relieving navigation from obstructions which existed

Digitized by Google

in the upper 9 miles of the river between Kinkora Bar and Trenton, particularly, under various appropriations aggregating $101,000 made by Congress during the period from June 10, 1872, to July 5, 1884, for improving the river between Trenton and Bordentown, between Trenton and Whitehill, and between Trenton, N. J., and Bridesburg, Pa. A channel 150 feet wide and 6 feet deep at mean low water was dredged through Perriwig Bar and a channel about 7½ feet deep at mean low water and 200 feet wide was constructed through the bar in the vicinity of Bordentown, N. J.

During 1890 a channel about 175 feet wide and 12 feet deep at mean low water was dredged through Kinkora Bar. A dike extending downstream from the lower end of Newbold Island was constructed with a view to assisting in the maintenance of this channel. The improvement, however, did not prove permanent, and it was found in 1893 that the channel had shoaled to about 7½ feet at mean low water.

By 1895 all traces of the improvements made previous to that time had disappeared. The river had practically returned to its original condition, and efforts toward improvements between Bordentown and Trenton had been failures.

During 1895 and 1896 a channel from 80 to 200 feet wide and 6 feet deep at mean low water was dredged through Perriwig Bar.

Expenditures to June 30, 1907, in connection with the various improvements of the river between Philadelphia and Trenton, amounted to $124,500.

A project for the construction of a channel 7 feet deep at mean low water and 200 feet wide through Perriwig Bar was adopted by the river and harbor act of March 2, 1907, in accordance with the plan printed in House Document No. 852, Fifty-ninth Congress, second session. The work under this project was completed during the fiscal year 1908 at a cost of $50,585.94.

A channel 160 feet wide, 7 feet deep at mean low water, and about 3,600 feet long was dredged through the bar in the vicinity of Bordentown during the summer of 1909 at a cost of $10,000. During the fiscal year 1910 a channel 800 feet long, 200 feet wide, and 7 feet deep at mean low water was dredged through Sewer Shoal just below Trenton at a cost of $12,537.31.

The total amount expended on all previous projects in the Delaware River between Philadelphia and Trenton from 1872 to 1910 was $197,623.25.

4. DELAWARE RIVER, PA., N. J., AND DEL., PHILADELPHIA, PA., TO THE SEA.

The act of Congress approved July 4, 1836, appropriated the sum of $15,000 "For removing the bar on the River Delaware, in the neighborhood of Fort Mifflin, with the view of improving the harbor of Philadelphia," which marked the beginning of the improvement of the channel of the Delaware River by the General Government. No further work on the channel was undertaken until 1872, when Congress appropriated the sum of $10,000 for improving the channel of the river between Trenton and Bordentown, N. J. Between 1872 and 1885 the work of improving the channel was confined to the removal of shoals and bars, except at Schooner Ledge, where solid

Digitized by Google

rock was removed. The work was carried on under appropriations for special localities and under general appropriations for improving the river below Trenton. The operations carried on between 1836 and 1885, with the amount of money expended on each, are shown in the following tabular list:

Locality.	Period.	Expended.
Improvement of Delaware River at Fort Mifflin Bar	1836–1876	$135,000.00
Improvement of Delaware River between Trenton and Bordentown	1872–1875	35,000.00
Improvement of channel of the Delaware River at and near the Horsehoe Shoals	1873–1874	500.00
Improvement of the Delaware River between Pettys Island and its mouth	1875–1878	83,359.15
Improvement of the Delaware River, N. J., between Trenton and White Hill	1876–1880	25,997.58
Improving Delaware River below Bridesburg	1879–1885	472,140.85
Improving Delaware River at Schooner Ledge	1879–1886	170,000.00
Improving Delaware River at or near Cherry Island Flats	1879–1886	400,000.00
Improving Delaware River between Trenton, N. J., and Bridesburg, Pa	1881–1885	30,002.42
Total		1,352,000.00

A comprehensive project for the permanent and systematic improvement of the river from a point about one-fourth mile below Allegheny Avenue, Philadelphia, Pa., to deep water in Delaware Bay, by the construction of a channel 26 feet deep at mean low water and 600 feet wide, was submitted on January 23, 1885, by a board of engineers appointed for that purpose (see Report of the Chief of Engineers for 1885, p. 822). It was proposed to secure the channel under this project by dredging wherever necessary, by the construction of dikes for the contraction or regulation of the tidal flow, and by the removal of rock obstructing the channel at Schooner Ledge, just below the city of Chester, Pa. The estimated cost of securing this channel was $2,425,000. Work under this project was commenced in 1885 and continued until superseded by a later project. The amount expended in connection with the 26-foot project was $1,532,688.81, of which amount $200,000 is estimated to have been applied to maintenance.

During the existence of the 26-foot project the sum of $146,963.26 was expended in deepening the channel across Smiths Island Bar, between Philadelphia and Camden, in rebuilding and enlarging the dike at the junction of the Delaware and Schuylkill Rivers, for dredging at various localities between Philadelphia, Pa., and Trenton, N. J., and for minor purposes not considered a part of the 26-foot project.

A comprehensive project for the improvement of Philadelphia Harbor was adopted August 11, 1888 (see H. Ex. Doc. No. 260, 50th Cong., 2d sess.), and the work was completed on January 10, 1898. Under this project a channel varying in width from 1,015 to 1,850 feet, with a least depth of 26 feet at mean low water, except over the Mameluke Rock area in the upper part of the harbor, over which the depth was slightly less than 26 feet, was secured from a point opposite Morris Street, Philadelphia, to the Pennsylvania Railroad bridge at Delair, N. J., a distance of about 6.2 miles. Final report on the completion of this project is published in the Annual Report of the Chief of Engineers for 1899, page 1330. The total amount expended in connection with this project, including survey of the locality, the acquisition of land, and the work done under the allot-

Digitized by Google

ment of $10,000 made from the emergency appropriation contained in the river and harbor act of March 3, 1905, was $3,945,424.75.

The 26-foot project of 1885 was superseded by a project providing for a channel 30 feet deep at mean low water, with a width of 600 feet, from Christian Street, Philadelphia, to deep water in Delaware Bay, adopted March 3, 1899, in accordance with report printed in House Document No. 219, Fifty-fifth Congress, second session. It was estimated that it would cost $5,810,000 to complete this work. Work under this project was commenced in 1900 and practically completed at the end of March, 1911. The amount expended under this project was $7,144,350.01, of which amount $6,318,940.99 was for new work and $825,409.02 was for maintenance.

The total amount expended under all previous projects for improving the river from 1836 to the time of the adoption of the existing project, in 1910, including the sum expended on Philadelphia Harbor, was $14,121,426.83.

5. ICE HARBOR AT MARCUS HOOK, PA.

The State of Pennsylvania, in 1785, through the agency of the wardens of the port of Philadelphia, constructed four piers and widened an old wharf at Marcus Hook "to shelter shipping." An agreement was made in 1785 between the Commonwealth and the holders of land at Marcus Hook which contained, among other conditions, "to permit and suffer all persons whatsoever to pass and repass across and along their respective wharfs and to permit and suffer all vessels lying at the public piers to load and discharge their cargoes without any let, hindrance, or molestation by or from them, or any or either of them, or their, or any or either of their heirs, executors, administrators, or assigns."

On September 29, 1789, the general assembly of the Commonwealth ceded to the United States "all right, title, property, and interest of this Commonwealth in and to * * * all * * * public piers now erected, placed, or sunk in the Bay and River Delaware, for the improvement and safety of the navigation thereof, * * * together with all the lands and tenements thereunto belonging * * * as fully, absolutely, and to the same extent, as this Commonwealth now holds and is entitled in and to the same, together with the jurisdiction thereof, so far as this Commonwealth hath or had right to exercise jurisdiction over the whole or any part of the same."

In the act of March 2, 1827, $100 was appropriated "for defraying the expenses of an examination of the public piers at Port Penn, *Marcus Hook*, and Fort Mifflin, in the River Delaware, in the States of Pennsylvania and Delaware, in order to determine the expediency and expense of repairing and improving the same."

The act of May 23, 1828, appropriated $4,413 "for repairing the public piers at Port Penn, *Marcus Hook*, and Fort Mifflin." The act of March 2, 1829, appropriated $5,000 for "repairing the piers at *Marcus Hook*, for filling up the sluice between the said piers, and improving the harbor of *Marcus Hook* by the removal of obstructions." The act of April 23, 1830, "for improving the harbors of New Castle, *Marcus Hook*, Chester, and Port Penn, in the Delaware River, ten thousand dollars." Act of March 2, 1831, "for improv-

Digitized by Google

ing the harbors of New Castle, *Marcus Hook*, Chester, and Port Penn, in the Delaware River, $4,000." Act of July 3, 1832, "for improving the harbors of New Castle, *Marcus Hook*, Chester, and Port Penn, on the Delaware, ten thousand dollars." Act of March 2, 1833, for same harbors "in the Delaware," $4,000. Act of June 28, 1834, for same harbors, $6,133. Act of March 3, 1835, for same harbors "in addition to balance of former appropriation, $6,000."

It is probable that reports upon the work done under the appropriations of 1829 to 1835 will be found in congressional documents of that period, none of which are on file in this office. The following resolution enacted January 22, 1846, by the general assembly of the Commonwealth is of interest in this connection:

Whereas, The piers in the River Delaware, at Marcus Hook, were ceded by this Commonwealth to the Government of the United States, on condition that the said Government should keep them in good and perfect repair: *And whereas*, The said piers are now in such condition as to render them almost useless for the public accommodation and convenience, the appropriation made several years since by Congress for the repairs of these piers and the protection of the harbor having been chiefly expended in procuring costly stone for the said piers, which was afterwards removed and applied to the erection of piers at New Castle, in the State of Delaware, thus removing the appropriation made for a national object in Pennsylvania to a neighboring State, where the appropriations were much larger: Therefore,

Resolved by the Senate and House of Representatives of the Commonwealth of Pennsylvania in general assembly met, That our Senators and Representatives in Congress be requested to insist upon the obligation of the General Government to keep the piers in the River Delaware at Marcus Hook in good order, and also to take such measures as will insure the proper repair of these piers by an appropriation equal to that which was explicitly made for this purpose, but which was abstracted to build piers in an adjoining State.

Resolved, That the governor be requested to transmit a copy of these resolutions to each of our Senators and Representatives in Congress.

The act of June 23, 1866, "For repairs of Government wharves and landings and improving harbor at *Marcus Hook*, on Delaware River, Pennsylvania, five thousand dollars: *Provided*, That before expenses shall be incurred on said wharves and landings it shall be shown to the satisfaction of the Secretary of War that the same belong to the United States." Act of March 2, 1867, "For improving harbor of *Marcus Hook*, Pennsylvania, $94,000." It is to be presumed that the ownership of the United States was satisfactorily established.

Major Stewart submitted a report and project under date of November 27, 1866, and an abstract of proposals for doing the work. He proposed to repair the old wharves, to build a wooden pier and bridge and four stone piers, at a total estimated cost of $84,000. The work was completed in 1871.

The next appropriation was made by act of June 14, 1880, "For ice harbor at *Marcus Hook*, Pennsylvania, commencing enlargement of piers and dredging, $35,000."

Previous to the above act, examinations and surveys were required by the acts of 1875 and 1879 as well as the act of 1827. The report made in compliance with the first act (1875) is found on page 181, volume 2, Annual Report of the Chief of Engineers for 1875, and on the second act on page 611, Annual Report of the Chief of Engineers for 1880 (also Sen. Ex. Doc. No. 80, 46th Cong., 2d sess.). Until a new project was adopted by the act of June 14, 1880, the expenditures annually made were for repairs to the ice piers and for dredging. A plan showing the condition of the ice harbor in 1879 will be

Digitized by Google

found in the Annual Report of the Chief of Engineers for 1879 opposite page 444. The new project provided for dredging and the construction of two additional ice piers, at a total cost of $90,000. The two piers were completed in October, 1881, at a cost of about $21,000.

A modification of the project of 1880 was proposed October 6, 1881 (see Annual Report of the Chief of Engineers, 1882, p. 751 et seq.), for building one additional pier, constructing a bulkhead along the whole length of the harbor (about 1,800 feet), and for dredging, at a total estimated cost of $74,000.

The act of August 2, 1882, approved the above project, the additional pier (No. 7) being completed in November, 1883. In the meantime one of the piers (No. 5) was wrecked and had to be rebuilt. During the year 1886 some dredging was done in the harbor to depths of 22 and 24 feet. Two groups of mooring piles were also placed. In 1887 Pier No. 6 was rebuilt in a new location and dredging was done which rendered available about 8 acres of harbor area, with a depth varying from 8 to 24 feet.

In 1888 the district officer, for reasons stated (see Annual Report of the Chief of Engineers, 1888, page 701 et seq.), recommended the abandonment of the bulkhead and dredging to a greater depth. A sketch of the harbor will be found opposite page 702 of that report. The acts of 1888 and 1890 appropriated funds for "Improving ice harbor at Marcus Hook, Pennsylvania; continuing improvement." It would appear therefore that the project of 1888 was not distinctly approved by Congress. Nevertheless the project as proposed by Col. Henry M. Robert in a letter dated August 9, 1888, was carried out and practically completed in 1889 (see Annual Report of the Chief of Engineers, 1889, p. 866). His project included also extensive repairs to the piers.

On November 13, 1901, a revocable license was granted by the Secretary of War to Mr. Joseph N. Pew, of Pittsburgh, Pa., to erect and maintain a wharf at Marcus Hook. The location of the wharf included the two lower ice piers, as shown on plan opposite page 1046, Annual Report of the Chief of Engineers for 1902. The wharf was afterwards extended. Rules for the use of the landing piers were approved by the Acting Secretary of War under date of April 29, 1904.

6. CONSTRUCTING PIER IN DELAWARE BAY, NEAR LEWES, DEL.

Prior to the adoption by the river and harbor act of July 15, 1870, of the project for the existing iron pier, there was a wooden pile landing pier about 1,200 feet long and 20 feet wide, having a depth of 8 feet of water at its outer end, which was constructed at this locality in 1837. This pier was erected for the purpose of providing communication with the shore for vessels coming to the harbor, so that provisions and supplies could be obtained and also to give access to lines of travel and afford mail accommodations. This structure was guarded by a series of six ice-breaker piers on the seaward side and a like series on the inner side placed 100 to 150 feet apart at distances of 75 feet from the landing pier. This structure cost about $60,000 and endured about 12 years. Its failure was caused by a vessel which broke through it after the piles had been honeycombed by boring worms.

Digitized by Google

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE WILMINGTON, DEL., DISTRICT.

3. MANTUA CREEK, N. J.

The original project, adopted by the river and harbor act of August 2, 1882, was for a channel 10 feet deep at mean low water and 80 feet wide at the mouth, diminishing to 4 feet deep at mean low water and 40 feet wide at Mantua. No work was done under this plan. The appropriation carried by the act was $3,000. In 1889 the project was modified to provide for a channel not less than 8 feet deep at mean low water and 60 feet wide from the Delaware River upstream 3,000 feet, and in 1889–90 the aforementioned channel was dredged with the funds provided by the act of 1882. The amount of dredging was 20,000 cubic yards.

4. RACCOON CREEK, N. J.

The original project adopted by the river and harbor act of August 2, 1882, was for a channel 4 feet deep at mean low water and 40 feet wide from the mouth to Springers Wharf and 3 feet deep at mean low water and 40 feet wide thence to the fixed highway bridge at Swedesboro. In adopting the project Congress appropriated $3,000 with which to start the work. The estimate of the cost of the work was $17,940. A survey of the creek was made at a cost of $757.23. No work was done under this project, nor further appropriations made.

6. SALEM RIVER, N. J.

The original project adopted by the river and harbor act of March 3, 1871, which carried an appropriation of $4,000, was for the removal of rock from the channel at the mouth to a depth of 9 feet at mean low water and a width of 200 feet. It was modified in 1878 to include the removal of a sand bar and other obstructions to a depth of 8 feet at mean low water. The rock was removed and the channel completed in 1881. Thereafter operations in Salem River to 1895 were confined to the portion of the river between the head of navigation and the Salem Canal, which in 1872 was dug by private enterprise, under authority from the State of New Jersey, from the point where the course of Salem River approached nearest the Delaware River to the Delaware River. This locality is just below Deep Water Point on the Delaware River and about 10 miles above the natural mouth of Salem River. In Salem River, just below the inner end of the canal and in connection with the digging of the canal, a dam was constructed, thus creating two distinct streams. Prior to the adoption of the present project, $17,209.34 was expended on the entire Salem River; $10,000 was applied to the channel in Salem Cove, which was dredged to a depth of 8 feet and a width of 100 feet, including the removal of the rock, which proved to be bowlders; and $7,209.34 was expended in making a channel 6 feet deep at mean low water and 50 feet wide from Hoxies Landing to the Salem Canal, in the upper river, which has been a separate stream since 1872.

Digitized by Google

8. COHANSEY RIVER, N. J.

The original project, adopted by the river and harbor act of March 3, 1873, was for a channel 4 feet deep at mean low water and 130 feet wide from deep water to the lower steamboat landing at Broad Street Bridge, and thence 3 feet deep, width not given, to the Nail Works Bridge at the head of navigation. The project was modified in 1879 to make the channel 5 to 7 feet deep at mean low water and 80 feet wide. Dredging operations were carried on from 1873 to 1881, in which time 63,532 cubic yards of dredged material were removed and the improved channel completed. The amount expended on the improvement was $36,000.

9. MAURICE RIVER, N. J.

The original project adopted by the river and harbor act of August 2, 1882, was for a channel 6 feet deep at mean low water and 100 feet wide from Frenchs Bar, 4 miles below Millville, to Millville drawbridge, and thence 4 feet deep at mean low water and 50 to 100 feet wide to the head of navigation about 3,000 feet. The project was modified in 1890 to extend the 6-foot depth to the head of navigation, and in 1892 to extend the head of navigation 500 feet. Operations were in progress from 1885 to 1892, and in that time 232,473 cubic yards of material were excavated in the improvement of the channel. The amount expended on the improvement under the previous project and modifications was $43,000.

15. WILMINGTON HARBOR, DEL.

Dredging operations were carried on in the Christiana River between 1836 and 1840, upon which was expended the sum of $32,356. The original project, adopted in 1870, was for a channel 12 feet deep at extreme low water, 200 feet wide from the Delaware River to the mouth of the Brandywine and 100 feet wide thence to Market Street Bridge, a distance of 3.1 miles. In 1881 this project was modified to provide a channel 15 feet deep at mean low water from the mouth to the pulp works, a distance of about 4.2 miles, and 12 feet deep thence for about 1.3 miles to the Delaware Railroad bridge, including rock removal at Third Street Bridge and a jetty at the mouth. It was again modified in 1883 to give a uniform width of 150 feet from the mouth to the pulp works, and again in 1884, to give an additional height of 4 feet to the jetty and an addition thereto of 322 feet. This project was completed in 1897, with the exception of the 12-foot channel 100 feet wide from the pulp works to the Delaware Railroad bridge, which work was never done, and the 322-foot extension to the jetty which was constructed after the adoption of the present project. The amount expended on the project of 1881 and its modifications was $369,765.21, making a total of $402,121.21 expenditure on projects previous to the existing project.

The river and harbor act of June 3, 1896, provided that $5,000 of the $20,000 appropriated by that act for Wilmington Harbor should be applied to dredging between Churchmans Bridge and Smalleys Dam, 11 and 16 miles, respectively, from the mouth of Christiana

Digitized by Google

River, during the year 1896. A channel 3 feet deep and 25 feet wide was dredged 3.35 miles upstream toward Christiana Village and from Christiana Village toward Smalleys dam, a distance of about 4,000 feet. The work was uncompleted at the end of 1896 in both sections and was never finished.

16. APPOQUINIMINK, MURDERKILL, AND MISPILLION RIVERS, DEL.

(c) MISPILLION RIVER.

The original project was adopted in the river and harbor act of March 3, 1879. It was for a channel 6 feet deep at mean low water and 40 feet wide from Delaware Bay to Milford. Operations were begun in 1879 and continued to 1889 when the project was completed at a cost of $17,000. A second project was adopted by the river and harbor act of July 13, 1892, for a channel across the bar outside of the mouth 6 feet deep at mean low water and 150 feet wide, the dredged material to form a protective bank on the northern side of the cut. This project was modified by the authority of the Chief of Engineers, July 3, 1893, to provide for the strengthening of the inshore end of the protective bank with a pile dike filled with brush. It later developed that, the dredged material being largely sand, the protecting bank would not stand, and 1,490 feet of jetty on the north side and 1,080 feet on the south side were constructed as a protection to the entrance channel. Operations under this project extended from 1893 to the adoption of the present project in 1907. The expenditures under this project amounted to $61,650, making a total of expenditures of $78,650 upon previous projects.

17. SMYRNA RIVER, DEL.

The original project adopted in the river and harbor act of June 14, 1880, was for a channel across the bar outside of the mouth and the removal of various shoals in the river to a depth of 8 feet at mean low water and widths varying from 50 to 100 feet. The work under this project was confined to the removal of the shoals in the river, no work being done on the bar at the mouth, and extended from 1880 to 1883. The amount expended on this project was $5,842.63. A second project adopted by the river and harbor act of August 11, 1888, was for a channel 7 feet deep at mean low water 100 feet wide across the bar outside of the mouth, protected by a stone jetty, and 60 feet wide in the river. A third project adopted by the river and harbor act of June 13, 1902, was for two cut-offs 7 feet deep at mean low water and 60 feet wide near the head of the river. This project was a modification of the second project. A modification by the river and harbor act of March 3, 1905, changed the location of the cut-offs as the original location was discovered to be detrimental to some shipping interests. Operations on this project extended from 1888 to 1910, when the present project was adopted and the improvement, including the cut-offs, but exclusive of the stone jetty at the mouth, was completed. The amount expended on this project was $71,965, making a total expended on previous projects of $77,807.63.

Digitized by Google

20. ST. JONES RIVER, DEL.

The original project adopted by the river and harbor act of March 3, 1881, was for a channel 3 feet deep at mean low water and 100 feet wide across the bar at the mouth to be protected by a jetty. A modification in 1884 included the removal of shoals in the river to a depth of 6 feet at mean low water between the mouth and Dover, and the cutting off of sharp bends. A modification in 1889 dispensed with the stone jetty, substituting banks thrown up along the sides of the cut, and included the dredging of a cut-off near Whartons Fishery, about 1 mile below Lebanon. Operations under this project and its modifications extended from 1884 to 1891, when the improvement was completed. From that date to 1910, when the present project was adopted, the improvement has been maintained as far as Lebanon, which is the head of steamboat navigation. The amount expended on this project and its maintenance was $70,556.50.

21. BROADKILL RIVER, DEL.

The original project adopted by the river and harbor act of March 3, 1873, was for a channel 6 feet deep at mean low water, of various widths, between Milton, the head of navigation, and the mouth, and the dredging to the same depth of a channel across the beach to form a new entrance into the river from Delaware Bay, at an estimated cost of $80,447. This project was modified in 1881 by the addition of jetty construction to protect the proposed new entrance. It was again modified in 1885 to provide for a channel 6 feet deep at mean low water and 40 feet wide from the mouth to Milton, cutting off some sharp points. This project was completed in 1890 so far as the dredging from Milton to the mouth was concerned, but the new entrance was not made. The amount expended on this project in the dredging operations was $35,000.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE BALTIMORE (MD.) DISTRICT.

---

1. PATAPSCO RIVER AND CHANNEL TO BALTIMORE, MD.

Date of original project, July 4, 1836. No dimensions were given; the law simply read "for deepening the harbor of Baltimore."

Modifications.—August 30, 1852. The Fort McHenry Channel from the limits of the city of Baltimore to a point just below Fort Carroll and the Brewerton Channel from this point to deep water in Chesapeake Bay were dredged 150 feet wide by 22 feet deep. Estimated cost unknown.

June 10, 1872. The project was enlarged to provide a width of 400 feet at the lower end of the channel, diminished to 250 feet at the upper end, with a depth of 24 feet. Estimated cost unknown.

March 3, 1881. After the completion of the project of 1872 it was found that the portion of the Brewerton Channel which was exposed

Digitized by Google

to the material brought into the bay by the Susquehanna River was continually obstructed by a sedimentary deposit. This led to a search for a better location for a deep channel which could be more easily maintained by dredging and the natural currents, and it was found on the line of the resultant of the two great forces made by the currents of the upper bay and Patapsco River. This new location had also the advantage of being shorter, and for this reason, the very much diminished sedimentary deposit and the consequent lessening of the cost of maintenance, it was adopted and the channel deepened to 27 feet at mean low water and widened to 600 feet in the straight sections and over 1,200 feet in the angles. At the same time the portion of the Brewerton Channel between the upper end of the present cut-off and the point of intersection of the Brewerton and Craighill Channels was abandoned. The estimated cost of this project was $1,250,000.

June 3, 1896. For dredging a channel 30 feet deep, 600 feet wide at bottom, and over 1,200 feet in the bends, with side slopes of 3 base to 1 vertical, at an estimated cost of $2,500,000.

2. CHANNEL TO CURTIS BAY, IN PATAPSCO RIVER, BALTIMORE HARBOR, MD.

Date of original project, July 15, 1892. It was for a channel 27 feet deep at mean low water and a bottom width of 150 feet from the Baltimore ship channel to the old sugar refinery wharf in South Baltimore Harbor. The channel was made 27 feet deep and 70 feet wide in the axis of the 150-foot channel with an appropriation of $40,000 of the $85,000 estimated cost. This project was never completed.

4. ELK AND LITTLE ELK RIVERS, MD.

Date of original project, June 23, 1874. It was for a channel 6 feet deep at mean low water or 8 feet at high water, from Cedar Point to Elkton, the head of navigation, and in the Little Elk as far as Bennetts Wharf. The estimated cost was $36,000 if 75 feet wide and about $25,000 if 50 feet wide, cheap dikes being required for regulating the banks and to provide a place behind which to deposit the material dredged from the shoals.

Modifications.—September 19, 1890. For dredging a channel 100 feet wide and 8 feet deep from deep water below Cedar Point to the bridge at Elkton. Estimated cost, $24,000.

June 13, 1902. For restoration of the project to the above dimensions at an estimated cost of $16,665 and $2,500 annually for maintenance.

March 2, 1907. For dredging a channel 6 feet deep and 100 feet wide from Elkton to Cedar Point at an estimated cost of $16,802.77. The act appropriated $18,803 for completion and maintenance.

5. SUSQUEHANNA RIVER ABOVE AND BELOW HAVRE DE GRACE, MD.

Date of original project, August 30, 1852. It was for a channel 12 feet deep and 100 feet wide from the mouth of the river to Havre de Grace, a distance of about 5 miles. The estimated cost was $59,000.

Digitized by Google

6. HARBORS AT ROCKHALL, QUENSTOWN, CLAIBORNE, AND CAMBRIDGE, AND CHESTER, CHOPTANK, WARWICK, WICOMICO, POCOMOKE, LA TRAPPE, AND MANOKIN RIVERS, AND TYASKIN CREEK, MD.

(A) ROCKHALL HARBOR, MD.

Date of original project, June 3, 1896. It was for a channel 80 feet wide and 10 feet deep at mean low water from the 10-foot curve in Swan Creek Inlet to the 10-foot depth in Chesapeake Bay and 100 feet wide and 10 feet deep from that depth in Swan Creek Inlet to the old pier at Rockhall, with a turning basin embracing the old and new piers. The estimated cost was $16,600.

(B) QUEENSTOWN HARBOR, MD.

Date of original project, March 3, 1871. It was for a channel 100 feet wide and 8 feet deep. The estimated cost was $9,500.

(D) CAMBRIDGE HARBOR, MD.

Date of original project, March 3, 1871. It was for an entrance way of 100 feet in width and of sufficient harbor accommodations of a depth of 10 feet at mean low water. The estimated cost was $36,000. This was extended by the act of July 13, 1892, for a channel 150 feet wide and 12 feet deep from that depth in Choptank River to the railroad wharf, a distance of nearly a mile. Estimated cost, $50,237.

(G) WARWICK RIVER, MD.

Date of original project, June 14, 1880. It was for a channel 7 feet deep and 75 feet wide from the mouth to the head of navigation, at Secretary Landing, about 1 mile. Estimated cost, $3,500.

(H) WICOMICO RIVER, MD.

Date of original project, June 10, 1872. It was for a channel 75 feet wide by 7 feet deep from the 7-foot contour below to the bridge at Salisbury, a distance of about 2 miles, with construction of dikes by private parties for retention of dredged material. Estimated cost, about $20,000.

(I) POCOMOKE RIVER, MD.

Date of original project, June 18, 1878. For removing obstructions and dredging a channel 7 feet deep and of varying widths between Snow Hill and Shad Landing, about 4½ miles. Estimated cost, $10,000.

Modification.—Act of August 5, 1886. For a cut-off below Snow Hill 80 feet wide by 7 feet deep, 1,100 feet long, through the low neck of land forming four abrupt bends. Estimated cost, $8,000.

(L) TYASKIN CREEK, MD.

Date of original project, June 13, 1902. It was for a channel 120 feet wide and 9 feet deep from the 9-foot contour in Nanticoke River to the wharf at Tyaskin, a distance of about 3,500 feet. Estimated cost, $13,200.

Digitized by Google

7. CORSICA RIVER, MD.

Date of original project, August 2, 1882. It was for a channel about 1¼ miles long, 100 feet wide, and 8 feet deep from the mouth to the wharf at Centerville, and a turning basin of the same depth 200 feet wide by 300 feet at the upper end. Estimated cost, $30,000.

10. TRED AVON RIVER, MD.

Date of original project, June 14, 1880. For a channel 8 feet deep and 150 feet wide from Peach Blossom Creek to Easton Point (a distance of 3 miles), with a turning basin at the latter point. Estimated cost, $8,250.

12. NANTICOKE RIVER, DEL. AND MD., AND NORTHWEST FORK OF NANTICOKE RIVER, MD.

Nanticoke River.—Date of original project, August 18, 1894. The item was for "Improving Broad Creek River, Del., continuing improvement, $5,000, of which so much as may be necessary shall be used for removal of bar that extends from the railroad bridge at Seaford toward the mouth of Nanticoke River." With this appropriation the channel was dredged where necessary to a width of 100 feet and a depth of 9 feet from the south side of the railroad bridge at Seaford to a point 8,000 feet below. A previous appropriation ($10,000) for Nanticoke River, made August 5, 1886, was, in accordance with the terms of the law, applied to Broad Creek River up to Laurel, Del.

Northwest Fork of Nanticoke River.—The original project is the present one.

13. BROAD CREEK RIVER, DEL.

Date of original project, June 14, 1880. For a channel 7 feet deep and 60 feet wide from the mouth to Laurel, Del., a distance of about 7 miles. Estimated cost, $46,500.

Modification.—Act of July 13, 1892. For a channel 70 feet wide and 8 feet deep between Bethel and Laurel, a distance of about 3 miles. Estimated cost, $15,000.

15. CRISFIELD HARBOR, MD.

Date of original project, March 3, 1875. For a channel 266 feet wide and 12 feet deep from above the railroad wharf to a point known as the "second angle" opposite Somers Cove Light, and from that point to deep water below, a channel of the same depth 425 feet wide, and, in addition, a basin on both the north and south sides of the railroad wharf 12 feet deep. Estimated cost, $37,317.50.

16. LOWER THOROUGHFARE, AT OR NEAR WENONA, DEAL ISLAND, MD.

Date of original project, March 3, 1881. For a channel 7 feet deep and 100 feet wide from Tangier Sound to the wharves of Daniel & Vetra & Son at Wenona, with a turning basin at the upper end, at an estimated cost of $10,000.

Digitized by Google

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE WASHINGTON, D. C., DISTRICT.

1. POTOMAC RIVER AT WASHINGTON, D. C.

In 1785 the "Patowmack Company" was organized under the direction of George Washington, by authority of the States of Virginia and Maryland, for the purpose of making the Potomac navigable from Georgetown to Cumberland, Md., from which point it was expected that a good road would lead to the Ohio River. To this end it did some open-channel work and built five short lengths of canal to surmount the chief obstacles which were found at Little Falls, Great Falls, Seneca Falls, Shenandoah Falls, and House Falls, the latter being about 5 miles above Harpers Ferry. Navigation was opened in 1802, but the facilities afforded were not satisfactory. After an existence of about 35 years and an expenditure of $700,000, the "Patowmack Company" became bankrupt. Agitation for a continuous canal was then begun, and such work was authorized by Virginia and Maryland in 1824 and by the United States in 1825. The United States engineers, under the immediate direction of Gen. S. Bernard, made a report, published in 1826, proposing the Chesapeake & Ohio Canal from Georgetown to Pittsburgh and the Ohio & Erie Canal from Pittsburgh to Lake Erie. The eastern section of the Chesapeake & Ohio Canal was estimated to cost $8,177,081.05, but the friends of the project declared this estimate excessive, and had another one made, amounting to $4,479,346.93. Funds were subscribed and this section was begun by the Chesapeake & Ohio Canal Co. in 1828 and was finally completed to Cumberland in 1850, at a cost of $11,290,327. The United States contributed $999,990 to the work.

The earliest improvement of the Potomac River at Washington, D. C., appears to have been undertaken by citizens of Georgetown. In 1804 they presented a petition to Congress stating that the channel was obstructed by a mud bank recently formed below Masons (Analostan) Island, and asking that Congress give permission for the erection of a dam to the Virginia shore, with the hope of improving navigation. This was authorized by Congress in an act approved January 19, 1805, and a short time afterwards the dam was built, but it did not have the desired effect. Later the corporation of Georgetown used a "mud machine" to cut a channel.

By an act approved March 2, 1833, Congress appropriated $150,000 "to aid the citizens of Georgetown in removing the obstructions to their navigation by causing the cut already made through the bar below the town to be enlarged and deepened, and for the further purpose of enabling them to make a free turnpike road on the Virginia side of the river, and to purchase and make free forever the bridge over Little Falls." The books of the corporation of Georgetown show that of this amount the sum of $5,000 was expended in deepening water on the bar below Long Bridge and $43,266.60 in dredging the cut above the bridge, making a total of $48,266.60 expended for the improvement of the river.

Digitized by Google

In 1849 $1,500 was appropriated for a survey of the river, and the sum of $1,208.61 was expended for this purpose and the balance covered into the surplus fund of the Treasury.

During the summer of 1869 the corporate authorities of Georgetown, at their own expense, caused the bar in the Georgetown or Virginia channel to be dredged out to a depth of 13 feet at low tide and a width of 80 feet, at a cost of about $10,000.

The first appropriation made by the National Government to be devoted wholly to the improvement of the river was an item of $50,000 in the river and harbor act of July 11, 1870. From this time to March 3, 1881, a total amount of $290,000 was appropriated by Congress for the improvement of the harbors of Washington and Georgetown. This sum appears to have been expended for dredging channels at first 14 feet and later 16 feet in depth in the Virginia channel and 12 and 15 feet deep in the Washington channel, and for the removal to a depth of 20 feet of the most dangerous rocks obstructing navigation in the harbor of Georgetown.

For more complete details of work under previous projects see Annual Report of 1883, pages 763 to 768. For map of location see Annual Report of 1877, page 356.

2. ANACOSTIA RIVER, D. C.

The act of September 19, 1890, provided that $20,000 of the appropriation for improving the Potomac River should be available for expenditure on the channel in the Anacostia River between the navy yard and Giesboro Point. Under this authority 90,217 cubic yards of mud were removed, to form a channel about 200 feet wide and 20 feet deep, and deposited on the adjacent flats at a cost of $18,536.94. (See Annual Report for 1892, p. 1035.)

A joint resolution of April 11, 1898, appropriated $2,000 for an examination and survey of the Anacostia River, and this sum was expended for that purpose. The report of the survey was printed in House Document No. 87, Fifty-fifth Congress, third session, with maps, and in Annual Report of 1899, page 1443, without maps. It provided for a development of the entire river within the limits of the District of Columbia.

7. (c) OCCOQUAN CREEK, VA.

The first project for the improvement, adopted by river and harbor act of March 3, 1873, was in accordance with the plan printed in Senate Document No. 25, Forty-second Congress, third session, and had for its object the dredging of channels 100 feet wide and 5 feet deep through Sand, Upper Mud, and Lower Mud Bars, at an estimated cost of $18,000. In 1879 a dike at Sand Bar was added to the project, increasing the estimated cost to $25,000. Appropriations made from 1873 to 1879 amounted to $25,000, sufficient to complete the project as above outlined. Channels of full projected dimensions were dredged through all three bars, and 876 linear feet of timber dikes were built at Sand Bar to secure permanency of the channel at that location. The amount of dredging was about 124,173 cubic yards. The expenditures on this project were $25,000.

Digitized by Google

The act of August 11, 1888, authorized a preliminary examination and survey, which was made during the year 1889. The plan of improvement proposed was for dredging channels through Occoquan, Sand, and Upper Mud Bars 100 feet wide and 8 feet deep, and through Lower Mud Bar 150 feet wide and 8 feet deep, and for building brush and pile mattress dikes at each of these bars, all at an estimated cost of $91,249.92. This 8-foot project was never adopted.

7. (*d*) AQUIA CREEK, VA.

The first project for improvement, adopted by river and harbor act of June 10, 1872, was in accordance with plans printed in Senate Executive Document No. 35, Fortieth Congress, second session, and the Annual Report of the Chief of Engineers for 1872, pages 708 to 710, neither of which contain maps, and provided for dredging a channel 40 feet wide and 6 feet deep from the Narrows to the natural 6-foot depth, about 2½ miles therebelow, at an estimated cost of $18,000. Congress made four appropriations, amounting to $10,500, the last being made on June 18, 1878, for completing the improvement. Accordingly, this project was completed with the expenditure of the $10,500 on December 25, 1878. The resulting dredged channel was about 1¾ miles long, 40 to 50 feet wide, and 4½ to 6 feet deep, and the amount of material excavated was about 67,576 cubic yards.

No further work was done until the second project was adopted by river and harbor act approved September 19, 1890. This project, based on plans printed in House Document No. 135, Fifty-first Congress, first session, with map, and in the Annual Report Chief of Engineers for 1890, pages 1096 to 1103, no map, provided for dredging a channel 150 feet wide and 8 feet deep from the mouth to the Narrows, for dredging a channel 80 feet wide and 8 feet deep off the mouth of Austin Run, and for the construction of a brush or timber dike at Austin Run, at the estimated cost of $101,278. This project as modified by the Secretary of War on December 4, 1890, provided for dredging a channel 80 feet wide and 6 feet deep from the mouth to the Narrows, work above the Narrows being omitted, at the estimated cost of $40,000, which was later reduced to $21,000. Between 1890 and 1896 Congress made four appropriations, amounting to $21,000, of which $463.36 was transferred to consolidated appropriation under the provisions of the river and harbor act of June 13, 1902. Accordingly, this project was completed on December 4, 1897, by the expenditure of $20,536.64, which resulted in dredging through all shoals having less than 6 feet depth between the mouth and the Narrows, in making a channel about 3½ miles long, 80 feet wide, and 6 feet deep, and in the excavation of 128,295 cubic yards of earth. The total expenditures under the two previous projects amounted to $31,036.64.

8. RAPPAHANNOCK RIVER, VA.

The act of August 30, 1852, appropriated $3,000 for a survey of the Rappahannock River. A partial report thereof, by Capt. Mansfield, dated November 26, 1852, is printed in Executive Document No. 60,

Digitized by Google

Forty-first Congress, third session, without maps. The survey was made by the United States Coast Survey at Capt. Mansfield's request in 1853–54. The amount appropriated was apparently expended.

The first project for the improvement of the Rappahannock River was adopted by the act of March 3, 1871, and is contained in House Document No. 60, Forty-first Congress, third session, with map. It provides for a channel 10 feet deep at low water and 100 feet wide, to be obtained by dredging the shoals and by blasting out the wrecks, and also for a few dikes and inexpensive jetties. The estimated cost of this project was $81,360.

The project was modified in 1879, as set forth in the Annual Report for 1879, pages 612–614, no map, so as to provide for a channel 10 feet deep and 100 feet wide between Fredericksburg and Port Royal and 15 feet deep and 200 feet wide below Port Royal. This channel was to be secured by dredging and maintained by wing dams and training dikes. The estimated cost of the modification was $290,345, in addition to the amount already spent.

The expenditures on these projects were $310,645.83. As a result of this expenditure channels were dredged through seven bars in the 13-mile reach of river below Fredericksburg, and timber dikes were built at some of them; about 510,128 cubic yards of material was dredged; 1,537 cubic yards of rock was excavated; 2,618 linear feet of dike repaired; 13,399 linear feet of dike built; and various miscellaneous work done. The project was in force until the present project was adopted in 1905.

9. URBANA CREEK, VA.

The original project for this improvement adopted by river and harbor act of March 3, 1879, based upon examination and survey, as printed in Annual Report of the Chief of Engineers for 1875, volume 2, page 139, which does not contain map, had for its object the excavation of a channel 150 feet wide and 10 feet deep through the outer bar at the estimated cost of $22,100, which was subsequently reduced to $20,000. It was modified in 1883 on recommendation of the Chief of Engineers and approval of the Secretary of War to include dredging through the inner bar and a turning basin at Palmers Wharf at the same estimated cost—$20,000. To June 30, 1884, $15,500 had been appropriated and expended. This expenditure resulted in a total dredging of 58,729 cubic yards in dredging the channels through the outer bar 1,200 feet long, 120 feet wide, and 10 feet deep, through the inner bar 1,090 feet long, 80 feet wide, and 10 feet deep, and a turning basin at Palmers Wharf 300 feet long, 200 feet wide, and 10 feet deep.

No further appropriation was made until August 11, 1888, when $3,000 was appropriated. On December 18, 1888, the project was extended upon recommendation of the Chief of Engineers and approval of the Secretary of War (Annual Report for 1889, p. 1010, which has a map) to protect the channel through the outer bar by a series of brush and oyster-shell dikes and brush mattresses, at an estimated cost of $37,580. Under this project $12,000 was expended. This expenditure resulted in a total dredging of 46,993 cubic yards and the construction of 452 linear feet of brush and oyster-shell dikes. The

Digitized by Google

dredging was done at Bailey Point and at the entrance to the creek, either in restoring depths or dredging and widening the cut at Bailey Point, to make more easy navigation. Three brush and oyster-shell dikes were built at Bailey Point, but by experience it was shown that these brush and oyster-shell dikes were not sufficiently substantial to withstand wave action during high winds, and accordingly the project was modified in June, 1897, to form the present project.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE NORFOLK, VA., DISTRICT.

---

1. HARBOR AT NORFOLK AND CHANNELS TO NEWPORT NEWS, VA.

Norfolk Harbor.—The original project for Norfolk Harbor was adopted in 1876 (river and harbor act of Aug. 14, 1876). This project provides for securing by dredging a channel 10 miles long, 500 feet wide, and 25 feet deep at ordinary low water from deep water in Hampton Roads to Norfolk Harbor, the improvement of the inner harbor by dredging through the bar of the Eastern Branch of the Elizabeth River, the deepening and widening of the channel at the mouth of the Southern Branch, and the provision of additional anchorage in front of Berkley and Portsmouth at an estimated cost of $378,000. Under it, up to June 30, 1885, a total of $383,032.81 had been expended, which resulted in a channel at least 25 feet deep at mean low water and not less than 200 feet wide from the deep water of Hampton Roads to the United States navy yard, a distance of 10 miles, and also a channel at least 22 feet deep at mean low water and not less than 200 feet wide in the Eastern Branch up to the Norfolk & Western Railroad bridge, a distance of 1 mile. A total of 2,635,648 cubic yards of material had been removed.

The project was revised in 1885 so as to provide by dredging a channel 25 feet deep at mean low water and 500 feet wide from deep water in Hampton Roads to Norfolk and the United States navy yard, a distance of 10 miles, and also to secure a channel in the Eastern Branch not less than 22 feet at mean low water, with a width of at least 300 feet to the Norfolk & Western Railroad bridge, a distance of 1 mile, and gradually increasing in width to 700 feet at the mouth. It was subsequently modified (Annual Report for 1886, Pt. 1, p. 148) so as to provide for excavating the 25-foot channel to within 75 feet of the pierhead lines on both sides of the river, the extension of the improvement with a depth of 22 feet at mean low water on the Eastern Branch to the Campostella Bridge, a distance of one-half mile, and the construction of a bulkhead on the Berkley Flats. The estimated cost of this work was $507,744.

The river and harbor act of September 19, 1890, provided for "improving the approach to the inner harbor and the United States navy yard at Norfolk by increasing anchorage between Lambert Point and Fort Norfolk," at an estimated cost of $150,000 (Annual Report for 1891, p. 1295), making the total cost of all improvements thus far authorized $1,041,774.56.

Digitized by Google

The execution of the project of 1885, modified in 1886 and 1890, up to June 30, 1898, had resulted in a channel with a depth of 25 feet at mean low water from Hampton Roads to the United States navy yard on the Southern Branch, a distance of 10 miles, and 500 feet wide, except between Fort Norfolk and Lambert Point, where the 25-foot channel was somewhat contracted, a channel 500 to 1,050 feet wide and 22 feet deep at mean low water in the Eastern Branch to the Norfolk & Western Railroad bridge, and an anchorage area of 75½ acres with a depth of 25 feet at mean low water. The total expenditure to June 30, 1898, was $1,122,500 (Annual Report for 1899, p. 224). A total of 8,883,747 cubic yards of material had been removed under all projects.

The deficiency act of July 7, 1898, provided for securing a channel 450 feet wide and 28 feet deep at mean low water from Hampton Roads to the navy yard at Norfolk, at an estimated cost of $360,000 (H. Doc. No. 531, 54th Cong., 1st sess.). This work was completed December 23, 1898, at a cost of $359,516.42. A total of 2,361,775 cubic yards of material, scow measurement, was removed.

The river and harbor act of June 13, 1902, provided for cutting away of 400 feet of Hospital Point to the depth of 25 feet at mean low water (Annual Report for 1897, Pt. 2, p. 1355), the dredging to a depth of 25 feet at mean low water on either side parallel to the established pierhead line to within 75 feet of it as far as the Seaboard Air Line Railway Wharf on the south and the Atlantic Coast Line Wharf on the north, and the rebuilding of Hospital Point Wharf and sea wall, which were demolished incident to the improvement. The estimated cost was $193,957. This work was completed March 9, 1906, at a cost of $186,147.66. The total material removed was 1,565,917 cubic yards.

Under the river and harbor act of March 3, 1905, the removal of Pinners Point to a depth of 28 feet at mean low water at an estimated cost of $20,000 was authorized. The work was completed October 18, 1905, at a cost of $13,864.40. The total material removed was 167,041 cubic yards.

On June 30, 1907, all work included in all preceding projects, estimated to cost $1,812,747.98, had been completed, excepting a part of the dredging in the Berkley Flats and in the Eastern Branch between the Norfolk & Western Railway bridge and the Campostella Bridge, at a total cost of $1,815,931.15, of which $51,052.16 was for maintenance. The total material removed under all projects was 14,687,115 cubic yards.

The river and harbor act of March 2, 1907, provided (H. Docs. Nos. 373 and 381, 59th Cong., 1st sess.) for deepening the existing channel to 30 feet at mean low water with a width of 600 feet from Hampton Roads to Lambert Point, and a width of 800 feet from Lambert Point to the junction of the Eastern and Southern branches of the river. The project also included the removal of shoals at the mouth of the Eastern Branch to a width of 500 feet and a depth of 25 feet at mean low water. The estimated cost of executing the project was $1,132,000. It was completed March 21, 1911, at a total cost of $682,297.10. The total material removed was 8,241,895 cubic yards scow measurement (Annual Report for 1911, p. 333).

On June 30, 1911, the year in which work started under the present project, all work under previous projects, the estimated cost

Digitized by Google

of which was $2,949,747.98, had been completed at a total cost of $2,554,782.56, of which $62,840.50 was for maintenance. The total material removed under all preceding projects was 23,240,105 cubic yards scow measurement. The main channel of the harbor was available at mean low water for ships of 30 feet draft as far as the navy yard, which is 10 miles from deep water in Hampton Roads. The Eastern Branch channel was available at mean low water for vessels of 22 feet draft as far as the Campostella Bridge, which is 11 miles from deep water in Hampton Roads.

Western Branch of Elizabeth River.—The original project for this improvement, adopted by river and harbor act of June 3, 1896 (H. Doc. No. 331, 54th Cong., 1st sess.), provided for obtaining, by dredging, a channel 200 feet wide and 20 feet deep at mean low water for a distance of about 1 mile from deep water in Norfolk Harbor, at an estimated cost of $45,000. The work was completed August 25, 1897, at a cost of $44,418.73. The total material removed was 482,033 cubic yards. (Annual Report for 1899, p. 225.)

The channel to Newport News.—The original project for this improvement, adopted by river and harbor act of June 13, 1902 (H. Doc. No. 93, 56th Cong., 1st sess.), provided for the dredging of a channel 2½ miles long, 500 feet wide, and 30 feet deep at mean low water south of the Middle Ground Light in Hampton Roads, Va., through the shoal known as "Middle Ground Bar," at an estimated cost of $225,000. The work under this project was completed February 3, 1905, at the estimated cost, with an additional expenditure of $12,500 for maintenance. The total material removed was 1,443,237 cubic yards, scow measurement. (Annual Report for 1905, p. 1189.)

2. NANSEMOND RIVER, VA.

A survey of this stream was directed by the river and harbor act of March 3, 1871. (Ex. Doc. No. 23, Senate, 42d Cong., 2d sess., and Annual Report for 1872, p. 723.) An estimate of $30,000 was made, based thereon, for procuring a channel 100 feet wide and 8 feet deep at mean low water, by dredging, regularization, and by the removal of wrecks, piles, fallen trees, snags, etc. This project was adopted by the river and harbor act of March 3, 1873, which appropriated $15,000 for the work. Additional appropriations aggregating $22,000, were made between 1874 and 1878, the estimate for completion having been increased to $37,000 in 1878, on account of the long period over which the work had extended, repairs, and the difficulty of finding dumping grounds. The project was completed November 3, 1877, excepting certain repairs to dikes, which it was deemed best to temporarily delay. The total expenditure to June 30, 1878, was $34,899.27, resulting in the removal of 29,159 cubic yards of material and the construction of 3,489 feet of dike.

3. JAMES RIVER, VA.

On the basis of a survey made by the United States in 1836, at a cost of $500, the United States expended, between 1852 and 1854, $22,500 in removing dangerous rocks and dredging in the channel of James River immediately below Richmond. The municipality of Richmond also expended at this time for the same purpose $21,300.

Digitized by Google

The general improvement of the river by the United States was begun in 1871. At this time its channel was obstructed not only by shoals and rocky reefs but also by sunken vessels and obstacles to navigation placed by military authority during the Civil War, principally in the 10-mile reach below Richmond.

The original project adopted by the river and harbor act of July 11, 1870, provided for excavating a channel between the mouth of the river and Richmond, including a canal at Dutch Gap, 180 feet wide by 18 feet deep at high water, equivalent to depths of 14.5 to 16.15 feet at low water, depending on the tidal range in different parts of the river. Operations under this project were proceeded with until 1884, the year of the adoption of the present project, principally in the 14-mile reach below Richmond. The work done consisted in removing sunken vessels and military obstructions, blasting and excavating rocky reefs, dredging, and constructing regulation works. It also included opening and enlarging the canal at Dutch Gap, which work had been begun but abandoned before completion during the Civil War. A small amount of dredging was done at Harrisons Bar and Goose Hill Flats, where narrow channels were formed with a depth of about 18 feet where the usable depths had previously been 15 feet. The result of work under this project was a channel with a usable depth of 12½ feet at low water and widths of 100 feet and upward. By the opening of Dutch Gap Canal to navigation 5 miles of channel were cut off, in which Trents Reach Shoal, with a depth of 8 feet at low water, was situated.

4. PAGAN RIVER, VA.

The river and harbor act of June 23, 1874, provided for a survey of this river. A report and estimate based upon this survey (Annual Report for 1875, Pt. 2, p. 146), provided for dredging a channel 8 feet deep at mean low water and 60 feet wide through four bars below Smithfield, at an estimated cost of $28,380.

The river and harbor acts of June 14, 1880, and March 3, 1881, appropriated $10,000 for this work. The money so appropriated was all expended by February 9, 1882. A total of 41,290 cubic yards of material were removed and a channel 8 feet deep at mean low water and not less than 60 feet wide was obtained.

A project for securing a channel 80 feet wide and 8 feet deep at mean low water was adopted by the river and harbor act of June 13, 1902, at an estimated cost of $28,870 (H. Doc. No. 88, 56th Cong., 2d sess., and Annual Report for 1901, p. 1474.) No work of construction was done under this project.

The river and harbor act of March 3, 1905, contained the following provision relative to the Pagan River:

> The Secretary of War may, in his discretion, expend the balance remaining to the credit of the said improvement with a view to securing a channel width of not less than 40 feet and such depth as may be obtained without exceeding said balance.

The project as modified was completed June 30, 1906, at a cost of $10,671.01, and a navigable channel 40 feet wide and 10 feet deep at mean low water had been secured from Smithfield to the mouth of the river, a distance of 5 miles. The material removed amounted to 81,672 cubic yards, scow measurement.

Digitized by Google

No work, either of maintenance or construction, was done on this stream between June 30, 1906, and June 30, 1910, the latter year being the date of the adoption of the present project.

5. APPOMATTOX RIVER, VA.

The original project for improving Appomattox River, Va., adopted by the river and harbor act of March 3, 1871, provided for dredging a channel 60 feet wide by 12 feet deep at ordinary high water, below Petersburg, Va., including the enlarging of a cut-off about 2 miles long, called Puddle Dock-cut, which had been begun by the city of Petersburg. The estimated cost was $367,600, with $10,000 annually for repairs to the banks and channel. The above project also provided for necessary regularization of the channel. By 1875 a channel with the dimensions of the project of 1871 had been obtained, and considerable progress made in constructing semi-permanent works of regulation and protection, comprising principally light pile and brush jetties and sheet piling training dikes. The project was modified in 1893 (Annual Report for 1893, p. 1336), in which provision was made for an expenditure of $48,090, with $20,000 for maintenance and repairs for two years. The total expenditure on the above projects, prior to the commencement of work under the adopted project, was $530,516.04, of which $471,020 was for original work and $58,596.04 for maintenance.

7. ONANCOCK RIVER, VA.

The original project (river and harbor act of Mar. 3, 1879, Annual Report for 1879, p. 716) provided for dredging a channel through the bar at the harbor mouth, and near the wharves 300 feet wide across the bar and 100 feet wide in the approach to the wharves at Onancock, and 8 feet deep at mean low water, at an estimated cost of $10,000. A total of $8,000 was appropriated for this work (river and harbor acts of Mar. 3, 1879, and June 14, 1880). Its expenditure resulted in a dredged channel 100 feet wide, and with depths at mean low water of 8 feet across the bar and 7 feet near and above Wise Point and near the wharves at Onancock. A total of 31,864 cubic yards of material was removed.

A resurvey of the harbor was directed by the river and harbor act of August 11, 1888 (Annual Report for 1890, pp. 968–971). The plan of improvement recommended therein is for a channel 300 feet wide at the outer bar, and 200 feet wide at the inner or middle ground, both to have depths of 8 feet at mean low water at an estimated cost of $12,511. This project was adopted by the river and harbor act of September 19, 1890, which appropriated $6,000 for the work. With this appropriation 26,778 cubic yards of material were removed, resulting in channels of the project depth, 1,100 feet of it being 150 feet wide and 500 feet 100 feet wide, at a cost of $5,931.40.

The river and harbor act of July 13, 1892, appropriated $6,511 to complete the project.

With this appropriation, and the balance remaining, 41,154 cubic yards of material were removed under contract, completing the project to the full dimensions on October 20, 1893, at a cost of $6,579.60.

Digitized by Google

The total expenditure under all previous projects was $20,511, which had resulted in a channel 100 feet wide and 7 feet deep at mean low water through the mud flats at Onancock, and channels 8 feet deep at mean low water and 300 and 200 feet wide through the outer and inner bars. The total material removed was 99,796 cubic yards.

9. INLAND WATER ROUTE FROM NORFOLK HARBOR, VA., TO ALBEMARLE SOUND, N. C., THROUGH CURRITUCK SOUND.

The projects connected with this improvement have always had for their object the improvement of the natural waterways which the two land cuts of the privately-owned Albemarle & Chesapeake Canal united to form a continuous water route from Norfolk, Va., to Albemarle Sound, N. C.

Before the consolidation of the improvement of the Southern Branch of the Elizabeth River, Va., North Landing River, Va. and N. C., Currituck Sound, N. C., Coinjock Bay, N. C., North River, and North River Bar under one project, known as the *Inland water route from Norfolk Harbor, Va., to Albemarle Sound, N. C., through Currituck Sound*, by the river and harbor act of September 19, 1890, these streams were improved under three separate projects, of which the following is a summary:

Southern Branch of the Elizabeth River, Va.—The original project for this stream was adopted by the river and harbor act of March 3, 1873, and provided for a channel 7 feet deep at mean low water and 60 feet wide from Deep Creek to the Albemarle & Chesapeake Canal lock, by dredging at bars, shoals, and abrupt bends, at an estimated cost of $25,000 (Annual Report for 1872, p. 715). The estimate was subsequently increased to $40,000 on account of additions to the project.

Between 1873 and 1879 dredging was carried on under various contracts for a distance of about 1 mile below the Albemarle & Chesapeake Canal lock, at Parks Gap, Nicaragua Bar, Deep Creek Bar, and at other lesser shoals.

In 1879 the improvement was reported completed, a channel not less than 7 feet deep at mean low water and about 60 feet wide having been secured from the canal lock to Deep Creek.

North Landing River, Va. and N. C.—The original project for the improvement of North Landing River, Va. and N. C., was adopted by the river and harbor act of March 3, 1879, and provided for the improvement of the river throughout its entire length of 17 miles, by dredging and snagging, so as to secure a channel 80 feet wide on the bottom and 9 feet deep at an ordinary stage of water, at an estimated cost of $88,000. (H. Doc. No. 68, 49th Cong., 3d sess., and Annual Report for 1879, p. 683.)

Dredging by contract was carried on between 1880 and 1882, in accordance with the approved project, by dredging a channel in the shoal parts of the river at Gordon's Wood Yard Reach, Devils Half Acre, Blackwater Flats, Stump Tree Reach, and Beacons 2 and 4. Points were cut off at sharp bends at Cypress Point and the lower end of Double S Bend. Logs and snags were removed and overhanging trees cut over the entire length of the river.

Digitized by Google

A total of $49,777.34 had been expended up to June 30, 1884, when the project was reported completed. The remaining funds were applied to maintenance work from time to time up to June 30, 1897, when the expenditures for all purposes amounted to $57,669.69.

Currituck Sound, Coinjock Bay, North River, and North River Bar, N. C.—A project adopted by the river and harbor act of June 18, 1878, provided for a channel 9 feet deep at ordinary winter stages and 80 feet wide in Currituck Sound and through North River Bar, N. C., at an estimated cost of $90,000.

The funds made available under this act and subsequent appropriations for the project were applied exclusively to dredging in Currituck Sound up to 1881, as it was not considered necessary to deepen the channel across North River Bar until deeper channels than then existed had been secured in Currituck Sound. As money was not appropriated in sufficiently large amounts to complete the work in a short period to full project dimensions, the channels dredged were made 50 feet wide instead of 80 feet wide, but the 9-foot project depth was adhered to.

The river and harbor act of June 14, 1880, modified the project so as to include Coinjock Bay, through which the Albemarle & Chesapeake Canal Co. had heretofore maintained a dredged cut. A project was submitted to the Chief of Engineers by Capt. Charles B. Phillips, Corps of Engineers, for the improvement of the channel through this bay, under date of December 28, 1880 (H. Doc. No. 28, 46th Cong., 3d sess., and Annual Report for 1881, p. 999), at an estimated cost of $53,213.95, which was subsequently approved and formed the basis of the work afterwards done. The proposed plan of improvement provided for a channel 9 feet deep and 80 feet wide, protected by a shell dike on its west side.

Contracts for dredging in Currituck Sound and Coinjock Bay were entered into from time to time as funds for the purpose became available until 1889, when a channel 50 feet wide, 9 feet deep at ordinary winter stages, and 10.5 miles long was reported as having been secured in Currituck Sound, and a channel from 40 to 80 feet wide, 9 feet deep at ordinary winter stages, and protected by a shell dike on its west bank was reported as having been provided in Coinjock Bay.

The original project was further modified by the river and harbor act of March 3, 1881, when for the first time North River, N. C., was brought under the project. No work, however, was done upon this stream prior to the consolidation of the separate projects in 1890.

In his report for the fiscal year ending June 30, 1885, Capt. F. A. Hinman, Corps of Engineers, recommended dredging a channel 7,150 feet long, 150 feet wide, and 9.4 feet deep at ordinary low water across North River Bar, at an estimated cost of $11,354.10. This work was done by contract in 1887 and 1888, but on account of insufficient funds a channel 8,350 feet long, only 40 feet wide, and 9.8 feet deep at ordinary low water was secured across the bar.

The amount spent upon Currituck Sound, Coinjock Bay, and North River Bar up to the time of the consolidation of the separate projects was $142,500. While the project depth was everywhere obtained, the full project width was attained at but few places on these waterways.

Digitized by Google

10. INLAND WATERWAY FROM NORFOLK, VA., TO BEAUFORT INLET, N. C.

The scope of previous projects will be found under the projects absorbed by this improvement.

12. BLACKWATER RIVER, VA.

The project adopted by the river and harbor act of June 18, 1878, was based upon a report upon an examination of the part of the river between Franklin, Va., and the mouth by United States Civil Engineer S. T. Abert, dated March 3, 1875 (Annual Report for 1875, pt. 2, p. 161), in which the dredging of points at a number of sharp bends, the dredging of shoals, the removal of snags and logs, and the cutting of overhanging trees were proposed, at an estimated cost of $14,850. Work upon the project was carried on under various appropriations until 1884, at a cost of $14,000, when the project was considered practically completed, a navigable channel with a minimum depth of 9 feet and of ample width was reported as having been secured.

No further work was done upon the river until after the adoption of the present project.

13. MEHERRIN RIVER, N. C.

The previous project adopted by the river and harbor act of August 2, 1883, was based upon an examination and survey report, dated January 16, 1882, by Capt. James Mercur, Corps of Engineers (Annual Report for 1882, p. 1114), in which the improvement of the stream below Murfreesboro, N. C., by a small amount of dredging and snagging was proposed, at an estimated cost of $12,500. An estimate of $4,000 was also submitted for improving the river above Murfreesboro to Princeton Landing, a distance of 5 miles. An appropriation of $5,000 was made by the act adopting the project, $4,584.53 of which was expended between Murfreesboro and the mouth in the removal of sunken logs, snags, and trees from the channel of the river between the years 1883 and 1885. A minimum depth of 8 feet was obtained by the project, but the improvement was subsequently abandoned, and the balance of the funds remaining turned into the Treasury, because no permanent benefit could be derived from the work, as logs and similar obstructions were permitted to sink in the river.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE WILMINGTON, N. C., DISTRICT.

---

1. SCUPPERNONG RIVER, N. C.

The original project, adopted by the river and harbor act of March 3, 1879, was to dredge the bar at the mouth of the river to obtain a channel 80 feet wide and 9 feet deep at low water, and to make cut-offs at sharp bends and to remove obstructions up to Spruills Bridge. The sum of $8,000 was expended on this project.

Digitized by Google

5. PAMLICO AND TAR RIVERS, N. C.

The original project for the improvement of Pamlico River (that is, the portion below Washington, N. C.), adopted by the river and harbor act of July 4, 1836, provided for the removal of a sand shoal. No records are available as to the location of this shoal or the depth and width to be obtained. Fifteen thousand dollars was expended on this project prior to 1853.

10. NEUSE AND TRENT RIVERS, N. C.

(*b*) TRENT RIVER.

The original project, adopted by the river and harbor act of March 3, 1879 (H. Ex. Doc. No. 68, 45th Cong., 3d sess.), provided for securing a channel 3 feet in depth at extreme low summer stage of water, with a width of 50 feet to Trenton. It was proposed to do but little work below Polloksville except to cut off a bend about 4 miles below the town. The estimated cost was $22,000. This estimate was increased in 1885 to $57,000 and in 1887 to $59,000. In 1889 the project was extended to clear out natural obstructions from Trenton upward for small steamboats over the first 30 miles and for pole boats for the remaining distance to the Upper Quaker Bridge, at an estimated cost of $13,000 and an estimated annual maintenance cost of $6,000.

In 1895 Maj. W. S. Stanton, district officer, reported it was his opinion that further effort to improve that part of the river from Trenton to the Upper Quaker Bridge should be given up by the United States, because it contained many bars of sand and rock or gravel, of which many had depths of only 12 to 18 inches; and if improved, the desire of the people interested was for drainage and not navigation.

In 1896 Lieut. Col. D. P. Heap, district officer, recommended the modification of the project to include maintenance below Trenton only and a channel only 30 feet wide and 3 feet deep. This modification was approved by the Chief of Engineers May 20, 1896. The total expenditure on these projects was $98,010.39, of which $70,905.40 was for improvement and $27,104.99 for maintenance.

14. HARBOR AT BEAUFORT, N. C.

The original project, adopted by the river and harbor act of July 4, 1836 (H. Doc. 482, 55th Cong., 2d sess.), provided for the improvement of the harbor, no data showing the scope of the improvement being available. Five thousand dollars was expended on this project.

18. NEW RIVER AND WATERWAYS TO BEAUFORT, N. C.

(*a*) NEW RIVER.

The river and harbor act of July 4, 1836, appropriated $5,000 for removing the oyster shoal in New River by dredging. The acts of March 3, 1837, and July 7, 1838, appropriated $20,000 and $25,000, respectively, for further improvement, the scope of which is not a matter of record.

Digitized by Google

The first project after the Civil War, adopted by the river and harbor act of August 2, 1882, proposed to secure a 150-foot channel 5 feet deep at low water from the upper river to the ocean by dredging, at an estimated cost of $40,000. (Ex. Doc. No. 169, 47th Cong., 1st sess.) This project was modified in 1886 by changing the location of the proposed dredging, and providing to start channels 150 feet wide and 4 feet deep at mean low water through Wrights Island and Cedar Bush Marsh, at an estimated cost of $40,000. (Annual Report for 1885, p. 1082.) Both these cuts were completed with various widths to the project depth, but the Cedar Bush Marsh Cut deteriorated at the upper end, and its abandonment was directed by the Chief of Engineers May 7, 1893.

The project of June 18, 1894 (Annual Report for 1894, pp. 1038–1039), to obtain 4 feet depth around Cedar Bush Marsh by dredging, and an experimental timber-training wall, at an estimated cost of $5,000, was adopted and successfully carried out.

The river and harbor act of March 3, 1905, authorized the balance from the project of 1894 to be expended in rebuilding the dike hitherto constructed. (H. Doc. No. 239, 58th Cong., 2d sess.; Annual Report for 1904, p. 1537.) Under this authority the dike was rebuilt with oyster shells. There was expended on these projects $83,807.82.

19. CAPE FEAR RIVER, N. C., AT AND BELOW WILMINGTON.

The original project, adopted by the river and harbor act of March 2, 1829, was to deepen by jetties the channel through the shoals in the 8 miles next below Wilmington. This project resulted in a gain of 2 feet available depth. The project adopted by the river and harbor act of July 22, 1854, was to straighten and deepen the bar channel by dredging, jettying, diverting flow from the New Inlet, and closing breaches in Zekes Island. This project was incomplete when the Civil War began.

Expenditures prior to Civil War (including balance transferred), $363,228.92.

After the Civil War the first project was adopted by the river and harbor act of July 11, 1870, to deepen the bar channel by closing breaches between Smiths and Zekes Islands, with the ultimate closure of New Inlet in view. The project adopted by the river and harbor act of March 3, 1873, included that of 1870, and in addition the dredging of the bar channel and closing of New Inlet. The project adopted by the river and harbor act of June 23, 1874, was to obtain by dredging a channel 100 feet wide and 12 feet deep at mean low water up to Wilmington. The project adopted by the river and harbor act of March 3, 1881, was to obtain by dredging a channel 270 feet wide and 16 feet deep at low water up to Wilmington. These projects had been practically completed in 1889.

The project adopted by the river and harbor act of September 19, 1890 (Annual Report for 1889, p. 1132), was to obtain a mean low-water depth of 20 feet and a width of 270 feet from Wilmington to the ocean, at an estimated cost of $1,800,000. This project was modified by the river and harbor act of June 13, 1902, to authorize the construction of mooring dolphins at Wilmington at a cost of $30,000, and to provide for the removal of obstructions at the mouth of

Digitized by Google

Brunswick River, at an estimated cost of $1,000. (H. Doc. No. 180, 56th Cong., 2d sess.)

The project adopted by the river and harbor act of March 2, 1907, provided for continuing improvement in accordance with report submitted in House Document No. 545, Fifty-ninth Congress, first session, for completion of the 20-foot project to the projected width by dredging and the excavation of a mooring basin in lieu of constructing mooring dolphins at Wilmington. The act also authorized improvement to such depth in excess of 20 feet as appropriations for the work might permit, due regard being given to the difference in tidal oscillation at the upper and lower portions of the improvement, and authorized so much as might be necessary of the funds available to be applied to repairing the New Inlet and Swash Defense Dams. The cost of these repairs was estimated at $165,000. Annual maintenance was estimated to cost $65,000.

Total expenditures on the above projects, including expenditures prior to Civil War, $5,240,572.39.

20. CAPE FEAR RIVER, N. C., ABOVE WILMINGTON (LOCKS AND DAMS).

The first slack-water project was adopted by the river and harbor act of June 13, 1902, and provided for the construction of three locks and dams at a cost of $1,350,000 to afford a depth of 8 feet at mean low water between Wilmington and Fayetteville. (H. Doc. No. 180, 56th Cong., 2d sess., or p. 1552 Annual Report for 1901.) Fifty thousand dollars was appropriated under this project, and of this amount $14,682.23 was expended for surveys and purchase of land at Kings Bluff. The balance of this appropriation ($35,317.77) was later covered into the surplus fund in accordance with section 10 of the sundry civil act of March 9, 1909. The present project was adopted June 25, 1910.

21. (c) CAPE FEAR RIVER, N. C., ABOVE WILMINGTON.

The original project adopted by the river and harbor act of March 3, 1881, proposed to buy out the navigation rights of private parties, then to clear out the natural obstructions in the river and to further provide a continuous channel over the 66 miles immediately below Fayetteville by dredging and by contracting its waterway by jetties through at least 32 shoals. (Ex. Doc. No. 78, 46th Cong., 3d sess., and pp. 741–749, Annual Report for 1872.) No depth or width of channel was specified, but in 1885 it had resolved itself into an attempt to "secure a thoroughly cleared 4-foot channel from Wilmington (73 miles) to Elizabethtown, thence a similar 3-foot channel 42 miles farther to Fayetteville, at all ordinary stages of water," estimated to cost $480,200. This project was in force until June 13, 1902, when it was abandoned, except for maintenance of the natural channel, pending the construction of locks and dams as authorized by the river and harbor act of June 25, 1910. From the beginning until the abandonment of the project $134,439.96 was expended for improvement and $8,177.67 for maintenance, making a total of $142,617.63 expended on this work. When the project

Digitized by Google

was abandoned the governing low-water depths were 4 feet from Wilmington to Kellys Cove, 2½ feet to Elizabethtown, and 2 feet to Fayetteville. Since the abandonment of this project various allotments have been made for maintenance from the joint appropriation for Northeast, Black, and Cape Fear Rivers, N. C.

22. SHALLOTTE RIVER, N. C.

The river and harbor act of Congress approved March 2, 1907, appropriated $3,000 to be expended on this river. This appropriation not being based on any project, the project submitted to and approved by the Chief of Engineers for the expenditure of the funds available became the project. This project was to dredge a channel 35 feet wide and 4 feet deep at low water, following the best water along the western shore, between a point 2½ miles above the inlet and a point 4 miles above the inlet. Three thousand dollars was expended on this project, which was completed.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENTS OF RIVERS AND HARBORS IN THE CHARLESTON (S. C.) DISTRICT.

---

4. WINYAH BAY, S. C.

Georgetown Harbor.—Operations for the improvement of navigation in Winyah Bay were begun in December, 1884, under a project to secure a channel 200 feet wide, 12 feet deep, and 2,850 feet long through the Sampit River bar immediately below Georgetown. The estimated cost was $14,000, but this was increased at various times up to 1889, when it was placed at $44,500. This amount was eventually appropriated. The increase was occasioned by the fact that the proposed channel traversed a submerged cypress swamp, which increased the cost of dredging, and also by the inadequate appropriations, which permitted damage to unfinished work and deterioration of plant, as well as extra superintendence. This project was completed January 10, 1893, at a total cost of $42,146.31, full channel dimensions having been obtained.

The work thereafter consisted in the removal of an occasional snag until 1900–1901, when the dredged cut, having shoaled and narrowed, was redredged to the extent of the available balance. This restored the channel to full depth for a width of about 125 feet. By the acts of June 6, 1900, and June 13, 1902, this project was virtually merged with that for Winyah Bay, in that legal authority was given to use any dredges employed in connection with the improvement of Winyah Bay for the purpose of dredging shoal places between the outer bar and the city of Georgetown, S. C.

Winyah Bay.—In the meantime the river and harbor act of August 5, 1886, had adopted a project to secure a channel not less than 15 feet deep at mean low water, to be obtained by two jetties springing, respectively, from North and South Islands and converging to 4,000 feet at the 18-foot curve on the seaward side of the bar. These

Digitized by Google

were to be constructed on a mattress foundation, with a riprap stone superstructure to a height of 6 feet above mean low water. As originally projected the north jetty was to be 10,700 feet and the south jetty 17,500 feet long. Construction work on the north jetty actually began on February 4, 1890, the interval since the adoption of the project having been occupied in surveys, studies of foundation conditions, construction of plant, and other preparations.

Under authority of the Chief of Engineers work was begun in 1892 on an earthen dike along the shore line of South Island, at the southerly side of the bay. Its purpose was to maintain the shore line, which had hitherto been held by a range of sand dunes. These had been swept away by storms, and it was necessary to prevent hurtful changes in the tidal regimen of the bay, caused by overflow at high tide from an extensive marsh in rear. The effect of this dike was augmented by "spur jetties" and some post-and-brush "sand catchers," or groins. This dike really served as the root of the south jetty, and as eventually built was 14,300 feet long. It has been necessary to repair it at intervals from the very first.

By the act of June 3, 1896, this project was placed under the continuing contract system at a cost not to exceed $2,016,250, inclusive of the $20,000 appropriated in that act. Work on the south jetty began March 15, 1898. The seagoing suction dredge was built and placed on the work September 19, 1898. By June 30, 1903, the north jetty had been carried out to the seaward end. It was then 11,139 feet long with a crest 4½ to 6 feet above mean low water, except that the outer 100 feet was submerged. At this time a depth of 15 feet had been obtained throughout the entrance, with a least width of 300 feet, and shoals within the bay had been improved. The south jetty was completed in 1904. It was 21,051 feet long with crest heights varying from 10 feet above mean low water at the inner end to nothing at the outer end. Thereafter dredging continued until June 30, 1909, when the 15 foot project was virtually completed. It was maintained until June 30, 1912, when the present project had been completed to such an extent as to render unnecessary any work on the previous project. Up to June 30, 1912, the expenditures on the 15-foot project had amounted to $2,398,351.88 for new work and $123,858.64 for maintenance, exclusive of the old Georgetown Harbor project.

5. MINGO CREEK, S. C.

The original project adopted by the river and harbor act of August 11, 1888, provided for a channel adequate for 5-foot-draft steam navigation to Williams Landing, and thence for a 5-foot-draft winter pole-boat navigation up to the head of such useful navigation, about 31 miles. This improvement was to be secured by snagging and clearing. Dredging was not contemplated. The estimated cost was $17,000, which was eventually appropriated. Work began on January 28, 1889, and a certain amount of snagging was done yearly thereafter up to 1897, excepting the year 1896, at which time the creek had been well cleared up to Williams Landing. By June 30, 1897, the appropriation was exhausted. That portion of the river for which steamboat navigation was projected had been thoroughly snagged, and steamers ran both by night and by day and at

Digitized by Google

either high or low water. The upper part of the creek had not been cleared.

No work was done thereafter until 1905–6 when, deterioration having occurred, $300 was allotted for the removal of obstructions and overhanging trees. Again, on March 18, 1908, $300 was allotted for a similar purpose. This provided for a draft of 8 feet to Hemmingway Bridge, 11 miles. By the river and harbor acts of June 25, 1910, and February 27, 1911, $2,000 was appropriated, none of which had been expended on the original project but was merged with the appropriation of July 25, 1912, for the present project.

6. SANTEE, WATEREE, AND CONGAREE RIVERS, AND ESTHERVILLE-MINIM CREEK CANAL, S. C.

(*a*) SANTEE RIVER AND ESTHERVILLE-MINIM CREEK CANAL.

The Colony and State of South Carolina in 1734, 1786, and 1809 undertook to improve this river, and especially its connection with the sea.

The original project adopted by the river and harbor act of March 3, 1881, contemplated securing unobstructed navigation of 7 feet at low water up to Wrights Bluff, about 120 miles from the ocean, and thence a 5-foot depth 23 miles farther to the confluence of the Wateree and Congaree Rivers. This was to be accomplished by snagging and clearing the river of overhanging trees and brush by blasting out a small rock shoal at one point on the upper river and by dredging at another shoal. A feature of the project was the conversion of Mosquito Creek into a canal to join the Santee River with Winyah Bay and thus avoid the passage of the Santee River Bar. Mosquito Creek was a tortuous tidal connection between the two bodies of water, and the project called for dredging and straightening to afford a 7-foot channel 50 feet wide and about 7 miles long. The original estimate placed the cost at $104,427.40. The total final cost of this work was estimated in 1886 at $271,300 for the outlet through Mosquito Creek and $75,200 for the Santee River proper, or a total of $346,500. By 1889 it had become evident that the canal would not prove adequate and satisfactory. The creek entrances were narrow, crooked, and shallow so that only rafts and boats not over 75 feet long, 18 feet wide, and 3 feet draft could pass entirely through from Winyah Bay to Santee River. The route was very exposed and liable to complete obliteration. Accordingly the present project was adopted by the river and harbor act of September 19, 1890.

9. CHARLESTON HARBOR, S. C. (INCLUDING ASHLEY RIVER AND SHIPYARD CREEK).

(*a*) CHARLESTON HARBOR.

Between 1871 and the spring of 1878 the General Government had expended the sum of $93,700 in taking up the wrecks of 14 ironclad and wooden vessels sunk during the war and in removing a portion of the Bowman Jetty projecting into Beach Channel with a view of improving the navigable channels of Charleston Harbor.

Digitized by Google

The original project, adopted in 1878, provided for establishing and maintaining by means of two jetties and auxiliary dredging a low-water channel of not less than 21 feet depth across the bar. The Swash Channel was selected for improvement. The estimated cost was $3,000,000.

In 1888 it became necessary to modify the height of the crest line of the jetties and to revise the estimate. This increase in the estimate was largely due to the fact that money had been appropriated so slowly that reasonable contract prices could not be obtained. The annual appropriation up to that time had been only 5½ per cent of the original estimate. In the revised project the jetties were increased in height and length, but no change was made in their position or distance apart. The revised estimates were $4,380,500 if the jetties were brought up to low-water level throughout, and $5,334,500 if brought up 3 feet higher. The former estimate was adopted by Congress in the river and harbor act approved July 13, 1892.

Under this project the jetties were completed in 1895 at a cost of $3,432,223, the north jetty having a total length of 15,443 feet and the south jetty of 19,104 feet, the width between them at the outer ends being 2,900 feet. The jetties had been brought to a height of 12 feet above low water for the greater portion of the length.

Dredging had also been carried on, a seagoing suction dredge having been constructed, and by June 30, 1899, a channel 250 feet wide and 21 feet deep had been procured. The total expenditures on the 21-foot project to this date were $4,037,256.70, of which about $670,000 was for dredging.

The project adopted by the river and harbor act approved March 3, 1899, provided for obtaining a channel at the entrance to Charleston Harbor not less than 26 feet deep at mean low water (mean range of tide about 5.2 feet) and 600 feet wide, by constructing a large seagoing suction dredge, at a cost not exceeding $150,000, and operating it, together with the existing dredge *Charleston*, for three years. The estimated cost of constructing the new dredge and operating all dredges, as above, was $285,000. Of this amount $175,000 had been appropriated prior to the enactment of the river and harbor act of June 13, 1902, which made available an additional sum of $208,000, increasing to $383,000 the amount authorized for the project for the new dredge and its operation. The entire amount authorized was appropriated.

This project was completed in September, 1906. Up to June 30, 1910, $636,749.86 had been expended, including $41,943.37 for maintenance during the four years since the completion.

(*b*) ASHLEY RIVER, S. C.

In 1880 the river was obstructed by two shoals in the lower part of the river, at a place named Accabee and just below the Wando Phosphate Works, with not over 9 feet of water on them.

By the act of Congress approved June 14, 1880, a depth of from 10 to 11 feet was to be secured by dredging. The plan comprised (1) the removal of a shoal at a place named Accabee, about 8 miles above the city of Charleston, where, according to a survey made in 1873, there was then only 9 feet of water at low tide, and (2) the

Digitized by Google

removal of a shoal just below the Wando Phosphate Works, where only 6 feet of water was found at low tide.

Four appropriations made for this work between June 14, 1880, and August 5, 1886, aggregating $5,500, were expended in improving the river at the places named above, securing and maintaining low-water depths of from 10 to 11 feet on widths of from 100 to 200 feet.

Between June 14, 1880, and June 30, 1892, 26,125 cubic yards of material had been removed and the desired depth had been secured and maintained. Dividing the total expenditures for all purposes to June 30, 1894, by the number of cubic yards dredged shows the cost to have been 21 cents per cubic yard. All dredging was done by contract. The total expenditures to June 30, 1895, were $5,500.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE SAVANNAH, GA., DISTRICT.

---

1. SAVANNAH HARBOR, GA.

Appropriations for the improvement of this harbor were made between 1826 and 1852, inclusive, amounting to $188,430.62, and had reference to the removal of natural and artificial obstructions, but the first comprehensive plan of improvement is dated February 11, 1853, which briefly was as follows (Annual Report for 1873, p. 737): "In February, 1853, a commission, organized under the War Department, * * * devised a project for the removal of obstructions in Savannah River at a place called 'The Wrecks' and the improvement of the navigation of said river," which received the approval of the Chief of Engineers and of Mr. Conrad, then Secretary of War. The essential features of this plan are as follows:

1. To deepen, widen, and straighten the channel over The Wrecks.
2. To close the channel between Fig and Hutchinson Islands.
3. To build a jetty at the lower end of Fig Island so as to deflect a considerable portion of the flood from Back River to Front River.
4. To build a deflecting work above Kings Island to increase the volume of ebb entering Front River.
5. To dredge at Tybee Knoll and other points as might be necessary.

The next plan of improvement is dated August 28, 1872, published in the Report of the Chief of Engineers for that year, page 653. This plan contemplated the removal of obstructions in the vicinity of Fort Jackson, in the North Channel opposite the upper end of Elba Island, and dredging at site of removal of these wrecks; also the dredging of a channel 125 feet wide, later changed to 250 feet, to depths from 12 to 12½ feet at five localities between the city of Savannah and Fort Pulaski. The total cost of this improvement was estimated to be $128,700 (Annual Report for 1872, p. 665). The Annual Report for 1873, page 734, gives the following summary of the work:

During previous years since January 1, 1865, a considerable amount of work has been done under other auspices comprising, first, the opening of a narrow ship channel through the line of cribs opposite the upper end of Elba Island in January, 1865; second, the removal of a number of wrecks, cribs, and other

Digitized by Google

obstructions by Mr. H. S. Welles under contract made May 1 and February 5, 1866, with the Treasury Department, annulled by the same authority January 18, 1870; third, dredging by the city of Savannah at a cost of about $157,000 expended for dredge boats, scows, steam tugs, labor, and superintendence prior to January 1, 1872, not including interest on original outlay. Total expenditure on Savannah Harbor from 1853 to January 1, 1872, was $454,132.96.

A project, adopted June 23, 1874, for 22 feet at high water, is outlined on page 747, Annual Report for 1873, and consisted of, first, the closing of Cross Tides by a crib dam with an opening for small vessels, the enlarging of the waterway opposite the city front to an average of 575 feet wide and 15 feet deep, the dredging from the city to the Knoll with a view of obtaining approximately 15½ feet at low water, and the construction of a bulkhead just above Kinseys Mill, at a total cost of $481,320.

Minor changes of the above project were made by the board of engineers, as given in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1876, page 77. Further modifications of the 22-foot high-water project are given in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1880, page 946. In this latter report of the board of engineers the project is approved with modifications, closing the channel between the islands and the North Channel, these channels being between Elba and Cockspur Islands; also including a sill dam at the head of South Channel. Cross Tides Dam is limited to 5½ feet above the bottom. The dredging work to be carried on simultaneous to the work of closing the side channels to keep the cross sections balanced. Steps were taken to widen the waterway in front of Fig Island.

The above are all the modifications of the 22-foot project at high water, and up to the adoption of the 26-foot project there had been expended upon this plan of improvement $1,207,964.95.

Just prior to the adoption of the 26-foot project there was reported and printed (H. Doc. No. 57, 50th Cong., 1st sess.) a proposed project for obtaining 28 feet at high water. This project considers the increasing of the tidal cross sections above the city by dredging Drakies Cut and portions of the channel and also for the construction of Cross Tides Dam to high water and the improvement of various stretches of the river from the upper portion of the city to the sea by means of contraction work, closing dams, and dredging, with an elaborate system of twin jetties at the mouth of the river, at a total cost of $6,660,000, including engineering and contingencies. However, this project was not adopted, but was later modified and considerably reduced in scope, as printed in House Document No. 123, Fifty-sixth Congress, second session, which was adopted by the river and harbor act of 1902, and has been termed the "28-foot project" and is touched upon later.

The "26-foot project at high water," as given in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1890, pages 1259–1263, was adopted September 19, 1890, and contemplated the enlargement of Drakies Cut, as indicated in the original project; the entire or partial removal of Kings Island; the construction of a deflecting jetty from Argyle Island; the partial removal of Marsh Island and the closing of the channel north of it: the construction of a training wall from the lower end of Marsh Island to MacKay Point and the widening of the unduly contracted

Digitized by Google

region below this point, all with a view to diverting a greater volume of flow through Front River. Contraction works were to be placed at Gardners Bank and Wrecks Channel. A deflecting jetty to be run out from MacKay Point in order to divert a greater ebb volume into the North Channel.

Besides the dredging as required to open the river as outlined above, a channel 26 feet deep at mean high water from the old waterworks to the sea was provided for.

The cross channels, or openings, between North and South Channels were to be closed and training walls and shore protections to be constructed between lower flats and oyster bed, with other minor work. The total estimated cost of the above was $3,537,720.

The project as outlined was practically completed in 1896, at which time there was a very great improvement in the channel depth amounting to a clear gain of 9 feet, and was modified under a report of the Board of Engineers dated June 22, 1896, which was based upon the provisions of the river and harbor act of June 3, 1896, which specifically named the projects dated December 7, 1894, and July 1, 1895, as regards Savannah Harbor, and that of January 22, 1895, for the steamboat channel by route No. 2 between Beaufort, S. C., and Savannah, Ga. All these projects assumed the continuance of the general improvement of 1890, including dredging, and modified it only by extension of certain walls and by additions of special features of work. The work thus specially named was as follows:

First. General dredging in the navigable channel at numerous points. (Project of July 1, 1895, as published in Annual Report for 1895.)

Second. Special dredging to secure the removal of the Middle Ground Shoal, opposite the quarantine, at an estimated cost of $350,000, paid for out of funds appropriated June 3, 1896. (Project of July 1, 1895, as published in Annual Report for 1895.)

Third. The construction of an extension of the oyster bed training wall, 2,500 feet long, and to a height of mean low water, together with—

Fourth. The construction of a detached portion of the same wall 8,000 feet long to a height of mean high water to lie along the crest of the shoal between Calibouge Sound and Tybee Roads, to serve as a breakwater to shelter the Tybee Roads anchorage grounds, at an estimated cost of $992,250 for both constructions, paid for out of the funds appropriated later by the river and harbor act of June 1, 1896. (Project of Dec. 7, 1894, H. Doc. No. 115, 53d Cong., 3d sess.)

Fifth. Dredging in Ramshorn Creek and Wrights River and extension of existing dam (No. 31) below the mouth of Wrights River to complete a steamboat channel of 7 feet at mean low water from Beaufort, S. C., to Savannah, Ga., at an estimated cost of $106,700, the connection between deep water and Wrights River and that in Savannah Harbor to be made along the line described as route No. 2. (Project of Jan. 2, 1895, published as H. Doc. No. 295, 53d Cong., 3d sess.)

This project was further modified upon the date of September 26, 1898, by the Board of Engineers, as follows: The removal of Cross Tides Dam; to maintain all the existing walls and dams; to do the necessary dredging to obtain and maintain a channel from Savannah to the sea suitable for vessels of 24-foot draft at mean high water; to establish and maintain three mooring dolphins between Savannah and the sea; to open and maintain a steamboat channel of sufficient width and 7 feet depth at low water from Beaufort, S. C., to Savannah, Ga., by way of Mud River, and to open and maintain a small-boat passage of 20 feet width and 3 feet depth at low water through the dikes and training walls near the foot of Elba Island.

Digitized by Google

This was the last modification of what is termed the "26-foot project," the total expenditures upon which amounted to $4,065,467.42.

(NOTE.—The money expended for steamboat channel between Savannah, Ga., and Beaufort, S. C., is now accounted for as a separate work by authority of Chief of Engineers, May 17, 1915.)

The next plan for improvement was for 28 feet at mean high water (H. Doc. No. 123, 56th Cong., 2d sess.), which is a modification of the project as outlined in House Document No. 57, Fiftieth Congress, first session. This project was adopted by Congress June 13, 1902, and provided for the establishment of a channel from the old waterworks to the sea 28 feet deep at mean high water, with a bottom width of from 350 to 500 feet, to be accomplished by dredging and the raising of all existing training walls between Savannah and Tybee Roads. It also provided for the construction of mooring dolphins in the harbor at two points, namely, the Bight and Venus Point. The estimated cost of the work was originally $1,567,791. This amount was increased by $210,000 by the river and harbor act approved March 3, 1905. This project was practically completed in 1905 at a cost of $1,643,282.29.

2. SAVANNAH RIVER BELOW AUGUSTA, GA.

The first appropriation for this work was made by the river and harbor act of March 3, 1881, which adopted a project (H. Doc. No. 23, 46th Cong., 3d sess., and Annual Report for 1881, p. 1090) which stated:

The plan of improvement * * * consists essentially of narrowing the river by low wing dams of brush and stone at points where excessive widths produce shoal; in aiding the formation of the low-water channel in a few localities by dredging; in removing snags, floating and overhanging trees, and pile obstructions, and in cutting off some projecting points. The object of these works is to establish a low-river navigable depth of 5 feet, and it is thought that this can be accomplished by narrowing the stream to a low-water width of about 400 feet or less.

To promote the building up of the bed of the river in the intervals between wing dams it was provided that two low hurdle traverses should be placed in each such interval. Caving banks were to be protected by thin flexible brush mattresses, weighted with stone. The estimated cost of the work under this project was $91,000, of which $25,000 was for the construction of a snag boat. No estimate was made for maintenance. There was expended under this project $93,480.09.

4. SAVANNAH RIVER ABOVE AUGUSTA, GA.

The first project for this work (Annual Report for 1879, p. 747) was adopted by the river and harbor act of June 14, 1880. This project was based on an examination without a survey, and provided for obtaining between Augusta and Trotters Shoals, a distance of 64 miles, a 3-foot pole-boat channel, 30 feet wide, at an estimated cost of $45,000. No estimate for maintenance was made. The channel was to be obtained by cutting through rock ledges, constructing rock wing dams, removing bowlders and other obstructions, and dredging. There was expended under this project $39,000.

Digitized by Google

5. INLAND WATERWAY BETWEEN SAVANNAH, GA., AND BEAUFORT, S. C.

The first project for this waterway was that adopted by the river and harbor act of June 3, 1896. It is that described as "Route 2" in House Document No. 295, Fifty-third Congress, third session. This report was reprinted, without maps, in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1895, page 1521.

The improvement of Savannah Harbor had included the closure of the old passages from the inland waterway to this harbor. On account of this the project for this waterway, which provided for the cutting of a new passage, was included by the river and harbor act of June 3, 1896, in the project for Savannah Harbor, adopted by the same act. The route selected was through Beaufort River, Port Royal Sound, Skull Creek, Calibogue Sound, Cooper River, Ramshorn Creek, New River, Walls Cut, Wrights River, and Savannah River. The project provided for a 7-foot channel, which was to be obtained by dredging at Ramshorn Creek and Wrights River, and by the construction of a dam 2,800 feet long connecting Dam 31 with Turtle Island. The estimated cost of improvement by this route was $106,700. No estimate was made for maintenance. This project was not fully completed, as it was found that the entrance into the Savannah River so near its mouth was undesirable, on account of its being too much exposed.

8. DARIEN HARBOR (AND DOBOY BAR), GA.

The first appropriation for Darien Harbor, amounting to $8,000, was made by the river and harbor act of June 18, 1878, without any project having been recommended or adopted. This sum was all spent in dredging, under contract. Channels 50 feet wide and 10 feet deep at mean low water, and aggregating 500 yards in length, were dredged through two shoals in Darien River north of Generals Island; a channel 75 feet wide, 14 feet deep, and 500 yards long was dredged in the North River below the Union Island sawmills and at the confluence of the Darien and North Rivers, known as the "Break," the channel was deepened from 8 to 12 feet and widened to 75 feet at mean low water. The aggregate quantity of materials removed amounted to 51,041 cubic yards. The increased depths secured vary from 2 to 4 feet.

The river and harbor act of June 13, 1902, by making a single appropriation for the two, combined the improvement at Darien Harbor and Doboy Bar into a single work. These works were afterwards separated by the river and harbor act of June 25, 1910, which made an appropriation for Darien Harbor alone, the improvement of Doboy Bar being virtually abandoned.

Prior to the submission or adoption of any project for Doboy Bar the river and harbor act of August 5, 1886, provided that $10,000 from the appropriation of the Altamaha, or as much of it as should be necessary, was to be used for the improvement of Doboy Bar. Under a project for the expenditure of these funds submitted December 11, 1886 (Annual Report for 1887, p. 1199), a small inner shoal was removed and a cut through the bar was attempted by harrowing and agitating the material of the bar with a water jet during the ebb

Digitized by Google

flow, when heavy northeasterly storms set in and interrupted the work. An examination made after about two weeks of storms showed no trace of the cut, which had been about 600 feet long, 60 feet wide, and from 2 to 3 feet deep. This work, which was experimental, had cost $5,795.40 and was not resumed.

The river and harbor act of March 3, 1899, adopted a project for dredging a channel through Doboy Bar to the north of the existing channel 24 feet deep at mean high water and 300 feet wide, requiring the removal of 450,000 cubic yards of material, at an estimated cost of $70,000. (H. Doc. No. 13, 55th Cong., 1st sess., reprinted without map, Annual Report for 1897, p. 1538.) In 1899 and 1900 there were dredged under this project 120,000 cubic yards of material. The contractor abandoned the work. Dredging was resumed with the U. S. seagoing dredge *Savannah* on November 4, 1905, and discontinued May 31, 1906, on account of exhaustion of available funds. A channel 150 feet wide, with a depth of 12 feet at mean low water (mean tidal range, 7 feet), had been created by the removal of 130,953 cubic yards of material. No work has been done since. The project was virtually abandoned by the river and harbor act of June 25, 1910, which made an appropriation for Darien Harbor alone, although this work had been previously consolidated with that for Doboy Bar. The expenditures under this project amounted to $49,134.14 for improvement and nothing for maintenance.

9. ALTAMAHA, OCONEE, AND OCMULGEE RIVERS, GA.

The improvement of each of these rivers was carried on as a separate work until they were consolidated by the river and harbor act of March 2, 1907, which, however, made no alteration in the individual projects.

ALTAMAHA RIVER.

The first project for this river was submitted November 27, 1880 (Annual Report for 1881, p. 1107), and the first appropriation for it was made by the river and harbor act of March 3, 1881. This project provided for securing a 3-foot channel, not less than 80 feet wide, by the excavation of rock shoals, dredging, and the removal of snags and other obstructions, at an estimated cost of $60,000.

Under this project the snag boat *Toccoa* was built for use on this river and the Savannah River, commencing work October 1, 1883. Altogether there were removed 2 piles, 936 snags and logs, and 1,849 overhanging trees. Channels 100 feet wide and 4 feet deep were opened through rock shoals at Town Bluff and Piney Bluff, and training wall and bank protection were constructed at Beards Bluff. With the exception of that done by the snag boat, all work was done by contract. There was expended under this project $58,981.19, not including $5,795.40 of the appropriation of 1886 allotted to Doboy Bar.

A project for establishing a navigable steamboat channel 3 feet deep at ordinary summer low water between the junction of the Oconee and Ocmulgee Rivers and the town of Darien, by (1) removing rock shoals and sand bars; (2) building deflecting dikes and closing incipient cut-offs; (3) removing snags and logs from the

Digitized by Google

channel and overhanging trees from the banks of the stream; and (4) revetting caving banks, at an estimated cost of $129,000 for improvement, and an annual expenditure of from $3,000 to $5,000 for maintenance, was adopted by the river and harbor act of September 19, 1890. (H. Doc. No. 283, 51st Cong., 2d sess., reprinted Annual Report for 1890, p. 1372.) Under this project there were removed 3 rock shoals, 10 sand bars, numerous snags, sunken logs, stumps, and overhanging trees, and the river was straightened at several points by cut-offs. The 10-inch suction dredge *Macon* was constructed for the use of this river and the Oconee and Ocmulgee Rivers. The expenditures under this project were $104,037.21 for new work and $33,442.39 for maintenance.

OCONEE RIVER.

The first appropriation for this river was made by the river and harbor act of June 18, 1878, a project having been submitted January 29, 1875, to secure a low-water channel 3 feet in depth from the confluence of the Oconee and Ocmulgee Rivers to Milledgeville, by removing rock ledges, shoals, snags, logs, and overhanging trees, at an estimated cost of $10,150. (Annual Report for 1875, Part II, p. 44.) This estimate was increased to $15,000 in 1878 (Annual Report for 1878, p. 768); to $50,000 in 1880 (Annual Report for 1888, p. 1704); and in 1888 to $100,000, with $5,000 annually for maintenance. (Annual Report for 1888, p. 1171.) Operations were carried on at irregular intervals as funds permitted commencing in 1878. A small amount of work was done in June, 1888, near the mouth of the river. A specific appropriation of $1,500 in the river and harbor act of August 5, 1886, for improving the section of the river between Skull Shoals and the Georgia Railroad bridge was expended so as to give a least depth in that reach of 20 inches at extreme low water. In all, there were removed from the river 2,234 snags and logs, 1,552 overhanging trees, and 487 cubic yards of rock. There were also some small brush jetties built. The expenditures under this project amounted to $44,822.18.

The river and harbor act of September 19, 1890, adopted a project for establishing a navigable steamboat channel 3 feet deep at ordinary summer low water from Milledgeville to the forks, by removing rafts, rock shoals, and sand bars; enlarging portions of the river; revetting caving banks; closing incipient cut-offs; removing snags and logs from the channel, and overhanging trees from the bank of the stream, at an estimated cost of $171,000, with from $3,000 to $5,000 for annual maintenance. (H. Doc. No. 211, 51st Cong., 1st sess., reprinted without maps or profile in Annual Report for 1890, p. 1430.) Under this project numerous logs, snags, stumps, bowlders, and overhanging trees were removed; several threatened cut-offs closed and others opened; 6 training dikes, 1 spur dam, and 900 feet of shore protection built; 23 rock shoals and several sand shoals removed, all below Milledgeville.

Under a provision of the river and harbor act of March 3, 1905, an isolated navigable section of the river, 17 miles long, extending from the Georgia Railroad bridge, 54 miles above Milledgeville, to the northern boundary of Greene County, was improved at a cost

Digitized by Google

of $3,000, by removing the most troublesome obstructions from the channel, and cutting numerous logs and overhanging trees on the bank. There was expended on this project for new work $171,596.74 and for maintenance $37,482.91.

OCMULGEE RIVER.

The first appropriation for the Ocmulgee River was made by the river and harbor act of August 14, 1876, which adopted a project for a 4-foot channel 80 feet wide from the forks to Macon at a cost estimated at $112,480. (Annual Report for 1875, Pt. II, p. 671.) This channel was to be obtained by the excavation of sand and rock shoals and the removal of sunken rafts, snags, logs, overhanging trees, and other obstructions. Under this project there were removed from the river 7,705 snags and stumps, 13,144 overhanging trees, 359 cubic yards of rock, and 1,869 cubic yards of earth; 112 logs were cut up on the bank, 801 trees were girdled, 2 jetties were built at Tillmans Bar, 2 snag dams were built at Ashleys Landing and 1 at Indian Timber Landing. The expenditures under this project were $79,390.73. The work done on the river enabled boats to run without accident at a stage 3 feet lower than was possible before improvement was begun.

The river and harbor act of September 19, 1890, adopted a project establishing a navigable steamboat channel 3 feet deep at ordinary summer low water from the forks to Macon at an estimated cost of $210,000 for original work and an annual cost of maintenance of from $3,000 to $5,000. (H. Doc. No. 215, 51st Cong., 1st sess., reprinted without maps in Annual Report for 1890, p. 1455.) The channel was to be obtained by removing rock shoals and sand bars, closing incipient cut-offs, revetting caving banks, removing snags and logs from the channel and overhanging trees from the banks of the stream.

Under this project there were removed from the channel 27,332 snags, logs, and stumps, 8 wrecks, and 2 old bridge piers; 1,722 trees were girdled and 121,143 overhanging trees, saplings, and logs were cut on the banks; 12 spur dikes were built at Tillmans Bar; 3 spur dikes aggregating 400 feet in length were built at Macon Bar; 1 spur dike was repaired; Atwoods Jetty was extended 155 feet; training dikes were built in the vicinity of Macon with an aggregate length of 8,089 feet. There was built at McRaes Bar a training dike 1,200 feet long; at Dents Landing one 460 feet long; at Mobley Bluff one 1,100 feet long; 1,100 feet of training dike were built at Buzzard Bar, 1,950 feet at Davis Reach, 350 feet at Mitchells Bar, 1,350 feet at Hollingsworth Ferry, and 757 feet at various other localities; the training dikes at Buzzard Bar, Davis Reach, and Mobley Bluff and 7,379 feet at other localities were repaired or rebuilt; 7,213 feet of bank protection was built in the vicinity of Macon; 278 feet at Tillmans Bar, 1,325 feet at Mansfields Bar, 561 feet at Newtons Place, and 506 feet at other localities; 2,250 feet of bank protection was rebuilt; Quinn Shoals, a rocky ledge, was partially removed; a clay point at Hubbard Shoals was blasted off; 3,149 cubic yards of rock were removed from Buttermilk Shoals, 625 from Town Shoals, 595 cubic yards from Collins Bluff Shoals, 394 from Seven Syca-

Digitized by Google

more Shoals, 195 from Gradys Shoals, 187 from Ways Shoals; 3,904 cubic yards of rock and 448 cubic yards of clay were removed from Tanyard Shoals; 1,218 cubic yards of rock and 499 cubic yards of earth from Taylors Bluff Shoals and 2,287 cubic yards of rock and 635 cubic yards of earth from various other localities; the cut-offs at Gees Point, Cow Face Bar, and House Creek Suck were opened up, there being removed 723 snags in this work, 852 stumps, 434 logs, and a large quantity of earth. This project was 95 per cent completed at a cost of $301,782.21 for new work and $41,025.02 for maintenance. Referred to the datum of the survey of 1889, upon which the project was based, the 3-foot channel had been obtained from the forks to within 6 miles of Macon; referred to the survey of 1909–1911, there was 1.2 miles in this part of the river in which the 3-foot channel had not been secured, and 1.3 miles additional within 6 miles of Macon, the controlling depth being approximately 2 feet.

11. BRUNSWICK HARBOR, GA.

Until they were consolidated by the river and harbor act of June 13, 1902, the improvement of the bar and of the inner harbor were carried on as separate works.

Inner harbor.—An appropriation of $10,000 made by the river and harbor act of July 4, 1836, was used in dredging a channel through the shoal at the lower end of East River.

The river and harbor act of March 3, 1879, adopted a project submitted April 29, 1876 (Annual Report for 1876, p. 486), for establishing a 15-foot channel 100 feet wide. Two plans of improvement were proposed. The first was for a jetty 3,400 feet long to be constructed at the lower end of East River on the south side of the channel, at an estimated cost of $57,000. This was to be supplemented by dredging should the shoal prove to be too hard to be removed by the scour produced by the jetty. The second plan was for removing the shoal by dredging alone, at an estimated cost of $52,500, including capitalized estimated cost of maintenance. In accordance with the instructions of Congress these plans and estimates were based on the information already on hand and not on a survey. Upon the adoption of the project a survey was made and a definite plan adopted. This called for contracting the channel at the lower end of Buzzards Island to a width of about 1,000 feet by means of 4,300 feet of jetty, and for the dredging of 90,000 cubic yards of material in the contracted channel, at a total estimated cost of $73,187.50. (Annual Report for 1880, p. 959.)

In 1886 a plan for the following additional work was submitted (Annual Report for 1886, p. 1113):

(*a*) A low dam across Turtle River, extending obliquely upstream from the upper end of Buzzard Island to the opposite shore of Blythe Island.
(*b*) Short spur jetties in the lower part of East River.
(*c*) Dredging in the vicinity of Turtle River Dam to facilitate the entrance of a larger amount of water into East River.
(*d*) The jetty to be raised to a higher and uniform level.
(*e*) Additional dredging on the shoal in the lower part of East River.

The estimated cost of the entire project was increased to $190,000. Subsequent work was carried on in accordance with this plan, except that the dam across Turtle River and the spur jetties in East River

Digitized by Google

were not built. Under a provision in the river and harbor act of June 3, 1896, a 12½-foot channel was dredged in Academy Creek.

A report of the district officer of November 26, 1894, recommended that the 15-foot channel be maintained by keeping the training wall in good condition and by annual dredging, instead of constructing the dam across Turtle River and further contraction works. He estimated the cost of annual maintenance at $15,000. This, like the preceding projects, was not formally adopted, but work was carried on in accordance with it until the adoption of the project of June 13, 1902.

Bar.—The river and harbor act of July 27, 1892, made an appropriation of $10,000 to be paid to a private individual upon his procuring, by the explosion of dynamite, a 22-foot channel, 100 feet wide across the bar at mean high water, on or before November 1, 1892. Additional sums of $10,000 were to be paid for each additional foot of depth secured up to include 25 feet, two months additional time being allowed for each additional foot of depth. An additional $10,000 was to be paid for securing a 26-foot channel, 125 feet wide, on or before October 1, 1893. Should the 25-foot channel be maintained for two years there was to be paid a further sum of $25,000, and for maintaining the 26-foot channel two years $25,000 additional. There was no payment made under this act.

A special act of March 1, 1893, made similar provisions, the time limit for each depth of channel being made November 1, 1893. There was no payment made under this act.

The river and harbor act of August 18, 1894, made an appropriation of $30,000 to the private individual specified in the river and harbor act of July 27, 1892, and in the special act of November 1, 1893, for the work done by him previously. It also made an appropriation of $30,000 to be paid to him upon his procuring by the explosion of dynamite, a 23-foot channel, 100 feet wide across the bar at mean high water, on or before November 1, 1895. Additional sums were to be paid as follows: For a 24-foot channel, 100 feet wide, to be procured on or before January 1, 1897, $40,000; for a 25-foot channel, 100 feet wide, to be procured on or before January 1, 1898, $50,000; and for maintaining the 25-foot channel for a period of two years, $25,000. There was paid under this act $30,000.

The river and harbor act of June 3, 1896, provided that when the private individual specified in the river and harbor act of August 18, 1894, should receive a certificate for a 24-foot channel, he should be paid $30,000 for a 23-foot channel in addition to the $40,000 for the 24-foot channel. It also provided that he should be paid $30,000 for procuring a 23-foot channel, 200 feet wide, and $40,000 additional for procuring a 24-foot channel, 200 feet wide, the time limit for both channels being three years from the date of passage of the act. He was paid $100,000 under this act.

The river and harbor act of March 3, 1899, extended to June 3, 1900, the time limit of the river and harbor act of June 3, 1896, for procuring a 24-foot channel, 200 feet wide, and extended to the same date the time limit of the river and harbor act of August 18, 1894, for procuring a 25-foot channel, 100 feet wide. There was paid under this act $90,000.

Digitized by Google

The river and harbor act of June 13, 1902, made an appropriation of $20,000 to a private individual for 50 feet excess width obtained by him in securing a 24-foot channel, and $25,000 additional for 50 feet excess width in securing a 25-foot channel under the provisions of the river and harbor acts of August 18, 1894, June 3, 1896, and March 3, 1899.

The river and harbor act of June 13, 1902, adopted a project providing for a channel 21 feet deep at mean low water in Brunswick inner harbor, at a cost of $120,000, and for a channel across the outer bar 19.3 feet deep at mean low water (26 feet deep at mean high water), at a cost of $40,000. The improvement of Academy Creek was also provided for. The river and harbor act of March 3, 1905, provided for maintaining in Academy Creek a channel of a depth equal to the controlling depth on the shoals at the lower end of East River, at a cost not to exceed $5,000.

Under these acts there was dredged throughout the inner harbor a channel 21 feet deep at mean low water, and 300 feet wide, and across the bar a channel 19.3 feet deep and 400 feet wide, and in Academy Creek a channel 18.5 feet deep and with a width ranging from 50 to 90 feet.

There was expended under this project $173,465.18 for new work and $19,596.82 for maintenance, a total of $193,062.

14. FERNANDINA HARBOR, FLA., AND CUMBERLAND SOUND, GA. AND FLA.

Until they were consolidated by the river and harbor act of June 25, 1910, the improvement of Fernandina Harbor, Fla., and that of Cumberland Sound, Ga. and Fla., constituted separate works.

CUMBERLAND SOUND, GA. AND FLA.

The river and harbor act of June 14, 1880, adopted a project (Annual Report for 1879, p. 792) to secure a low-water channel 20 to 21 feet deep across the bar at the entrance to the sound by means of converging jetties carried out to the 16-foot contour. The distance between the outer ends of the jetties was to be from 3,000 to 3,500 feet. The north jetty was to have a length of a little over 18,000 feet, and the south jetty a length of a little over 12,000 feet. The crests of the jetties were to be at the level of mean low tide, except the outer five-eighths of a mile, which was to be carried to the level of half tide. The estimated cost of the work was $2,071,023.

The river and harbor act of July 13, 1892, adopted a revision of the project. (Annual Report for 1891, pp. 1565 and 1598.) This revision provided for obtaining a channel at least 19 feet deep at low water, and fixed 3,900 feet as the width between the outer ends of the jetties, which were to be prolonged to deep water from the portions already constructed by the shortest lines. The north jetty was first to be raised to a height to stop effectually the sand movement southward. Then the south jetty was to be raised and extended as should be found necessary to secure the desired depth over the bar. The estimated cost for low jetties was $1,706,500 and for high jetties $2,079,500. There was expended on these projects $932,500.

Digitized by Google

16. INSIDE WATERWAY BETWEEN SAVANNAH, GA., AND FERNANDINA, FLA.

The improvement of Romerly Marsh, Ga., and that of Jekyl Creek, Ga., were undertaken as separate works. Upon the adoption in 1892 of the first project for the inside waterway as a whole, they were incorporated in it. In 1905 the improvement of Skidaway Narrows was undertaken as a separate work, but was incorporated in the present project for the inside waterway when it was adopted in 1912.

ROMERLY MARSH, GA.

The river and harbor act of August 7, 1882, adopted a project for dredging through Romerly Marsh a 7-foot channel 48 feet wide, connecting Dead Man's Hammock Creek with Wassaw Creek, at an estimated cost of $38,720. (Route No. 4 of H. Doc. No. 19, 46th Cong., 3d sess., reprinted without appendices in the Annual Report for 1881, p, 1159.)

Under this project a channel 7 feet deep at mean low water and 50 feet wide was cut through the marsh and in Wassaw Creek to deep water. The total length of continuous cut was 4,117 feet, of which 3,547 feet was through the marsh. In addition there were dredged three shoals in Wassaw Creek aggregating 1,600 feet in length. This work required the removal of 211,562 cubic yards of material, of which 99,120 cubic yards was dredged by private parties, who received $22,108.77 as reimbursement by appropriations in the river and harbor acts of August 5, 1886, and August 11, 1888. There was expended in this improvement $47,108.77, of which $5,000 was contributed by local interests.

JEKYL CREEK, GA.

The river and harbor act of August 11, 1888, adopted a project (H. Doc. No. 19, 46th Cong., 3d sess., reprinted without appendices in the Annual Report for 1881, p. 1162), which included the following features:

(*a*) A training wall 2,700 feet long on the west side of the channel at the mouth of Jekyl Creek.
(*b*) A closure dam 200 feet long in Mud River at its mouth or junction with Brunswick River.
(*c*) The dredging of a shoal at the mouths of Lathram and Mud Rivers.
(*d*) The dredging of a shoal at the mouth of Jekyl Creek.

The estimated cost of the work was $25,323.

Appropriations amounting to $24,000 were made for this improvement and expended on it as a separate work up to July 13, 1892, when it became a portion of the project for the inside water route between Savannah, Ga., and Fernandina, Fla., adopted on that date. These appropriations having been insufficient to complete the work, it was continued and finished June 29, 1905, on substantially the original plan, under appropriations for the inside water route. There were expended of these latter funds $35,000, the entire improvement having cost $59,000. The work accomplished was as follows:

A training wall 2,600 feet long was constructed at the mouth of Jekyl Creek. The shoals in the creek and the one at its mouth were

Digitized by Google

dredged, securing a channel 7 feet deep at low water and 90 feet wide. There was dredged from the shoal in the creek at various times 22,375 cubic yards of material, and from the shoal at the mouth 40,955 cubic yards, making a total of 63,330 cubic yards.

INSIDE WATERWAY.

The first complete project for the inside waterway was adopted by the river and harbor act of July 13, 1892 (H. Doc. No. 41, 52d Cong., 1st sess., reprinted in the Annual Report for 1892, p. 1309). It provided for the establishment of a channel 7 feet deep at mean low water, from Savannah, Ga., to Fernandina, Fla., to be accomplished by the improvement of Romerly Marsh, Mud River, Little Mud River, and Jekyl Creek, by means of dredging and the construction of closure dams and training walls of brush mattresses loaded with riprap stone. The estimated cost of the improvement was $105,000, provided that the entire sum were made available at one time.

The first work done under this project was a continuation of the improvement at Jekyl Creek, which had been begun as a separate work prior to the adoption of this project. This work, which consisted in the finishing of the training wall at the mouth of the creek, and in dredging, was completed June 29, 1905, substantially in accordance with the original plan. In 1897 an 8-foot channel 45 feet wide was redredged through the shoal at the mouth of this creek, and a 7-foot channel, from 40 to 90 feet wide, was dredged through the shoals in Big Mud River. Subsequently shoals were dredged at Skidaway Narrows, Florida Passage Dividings, New Tea Kettle River, Little Mud River, Frederica River, and Cumberland Dividings. At all of these localities redredging was necessary one or more times. A training wall 2,000 feet long, with its crest at the level of mean tide, was constructed and maintained in Jekyl Creek, about a mile from its mouth. A small dam was built in Little Mud River near its outlet into Brunswick River. There was expended under this project $68,388.19 for new work and $134,776.21 for maintenance, a total of $204,164.40.

SKIDAWAY NARROWS, GA.

The river and harbor act of March 3, 1905, adopted a project for a channel 6 feet deep at mean low water, 75 feet wide, in Skidaway Narrows and the connecting portions of Skidaway River and Burnside River. This was to be accomplished by dredging and the construction of 3 cut-off dikes at an estimated cost of $55,000. This formed an alternate route of the inside waterway, the regular one being via Romerly Marsh and Habersham Creek.

Under this project a 6-foot channel, with a bottom width of 75 feet in the straight portions and increased in the bends, was dredged from deep water in the Skidaway River to deep water in the Burnside River. Work was begun October 23, 1905, and the project was completed November 20, 1908, 341,211 cubic yards of material having been dredged. There was expended under the project $55,000 for improvement and nothing for maintenance.

Digitized by Google

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE JACKSONVILLE, FLA., DISTRICT.

1. CHANNEL BETWEEN ST. JOHNS RIVER AND CUMBERLAND SOUND, GA. AND FLA.

The first project for the improvement of this waterway was adopted by Congress in the river and harbor act of May 23, 1828, which appropriated $13,500 "for deepening the inland passage, or present channel, for navigation between the St. Johns River in Florida and St. Marys Harbor in Georgia." Between 1828 and 1838 appropriations aggregating $78,000 were made and expended chiefly in dredging Kingsleys Cut, connecting Amelia River with South Amelia River, and Gunnisons Cut, connecting Sawpit Creek with Sisters Creek and Fort George River.

By the river and harbor act of June 23, 1874, $10,000 was authorized to be expended "for dredging out the inside passage between the St. Johns and Nassau Inlet." A survey was made and report submitted under date of June 14, 1875, which is printed in the Annual Report of the Chief of Enginers for the fiscal year ending June 30, 1875, Part II, pages 48–59. A channel 80 feet wide by 11 feet deep at high water, at an estimated cost of $160,000, was recommended. Appropriations aggregating $24,000, made from 1874 to 1880, were applied to this work. The total expended was $19,565.55. Owing to changes in transportation conditions and the adoption of the project for improving the entrance to the St. Johns River, which reduced the importance of this improvement, the work was abandoned December 1, 1880, and the unexpended balance was returned to the Treasury. A channel 4 feet deep and 40 feet wide was dredged through the shoals betwen the St. Johns River and Nassau Sound, but it soon shoaled to 2½ feet, in which condition it remained until the adoption of the present project.

2. ST. JOHNS RIVER, FLA., JACKSONVILLE TO THE OCEAN.

The first appropriation for this river was $10,000, made by the river and harbor act of August 30, 1852. A survey of the river from the bar to Jacksonville was made by a Coast Survey party and a contract was made for maintaining for a time a depth of water over the bar sufficient for the vessels engaged in the trade, but no material improvement was effected. A total of $9,172.83 was expended, and the balance of the appropriation was returned to the Treasury. Between 1870 and 1878 appropriations aggregating $60,000 were made and expended in surveys and tentative annual dredging on the bar, with a view to maintaining a practicable 10-foot channel. No permanent results were obtained.

The first project for the permanent improvement of the bar was adopted by the river and harbor act of June 14, 1880, and was based on report of June 30, 1879, printed in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1879, pages 767–792. This project contemplated a channel over the bar, 15 feet deep at mean low water, to be obtained by building two converging

Digitized by Google

jetties to the 16-foot curve beyond the bar and by dredging and raking between the jetties. The north jetty was to be 9,400 feet long and the south jetty 6,800 feet, and the width between the jetties at the bar was to be 1,600 feet. The jetties were to be built of stone on a mattress foundation. The estimated cost of the work was $1,306,409. Deepening of the shoalest places in the river between the mouth and Jacksonville, at an additional estimated cost of $120,000, was also recommended. This project, so far as the work at the mouth was concerned, was practically completed in 1896, at a total expenditure of $1,417,000. Nothing was done in the river above the mouth, except surveys and preparation of plans for work at and below Dames Point.

A project for securing 15 feet through the defective reach from Dames Point to Mile Point was approved by the Chief of Engineers on June 11, 1891, and was recognized by the river and harbor act of July 13, 1892. A modification of this project providing for dredging, dikes, and shore protection to secure a depth of 18 feet at mean low water and a width of 200 feet, was approved by the Secretary of War March 28, 1892. The estimated cost of the work was $324,201. This project was carried through to completion by Duval County, under the supervision of the War Department. It was completed in 1894, at a total cost of $303,206.25, provided by Duval County.

The third project, adopted by the river and harbor act of June 3, 1896, was based on plans and estimates printed in House Document No. 346, Fifty-third Congress, third session. The project contemplated a channel from Jacksonville to the ocean 300 feet wide and 24 feet deep at mean low water, to be secured by dredging and construction of mattress and stone training dikes in the river and by extending the north and south jetties 1,500 feet and 500 feet, respectively, and raising both to mean high water throughout their length, all at an estimated cost of $2,109,750. This project was practically completed in 1911, at a total expenditure of $2,577,363.08, of which $2,033,964.56 was for original work and $543,398.52 was for maintenance. The project was practically completed for $75,785.44 less than the original estimate.

5. ST. JOHNS RIVER, FLA., PALATKA TO LAKE HARNEY.

The first provision for the improvement in this stretch of river was made by Congress in the river and harbor act of July 14, 1880, under the title of "Improving Volusia Bar, Fla.," and is based on report printed in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1879, pages 795–798. The project provided for the improvement of Volusia Bar, at the head of Lake George (43.2 miles above Palatka), by building two jetties on the bar, carried out to 5½ or 6 feet of water, with their ends 200 to 250 feet apart, with a view to obtaining a permanent channel about 6 feet deep. The estimated cost of the work proposed was $15,000. In 1883 the estimate was increased to $21,100, to provide for extending and raising the jetties and supplementing their effect by dredging; and in 1884 the estimate was again increased to $25,000. The work proposed was completed in May, 1887, at a cost of $24,287.43 for construction. Two jetties were built, 3,400 and 2,200 feet long, and the depth on the bar was increased to 5 feet, and it was decided not

Digitized by Google

to attempt to obtain a greater depth, as 5 feet was sufficient for the navigation then existing. Between 1887 and 1902 the sum of $6,712.57 was spent in repairs and maintenance of this work.

A second project for improvement in this stretch was inaugurated by Congress in the river and harbor act of July 5, 1884, which appropriated $5,000 for the improvement of the river between Lake George and Lake Monroe, a distance of 46 miles. A plan of improvement was submitted and approved, contemplating cut-offs 100 feet wide and 6 feet deep at four of the worst bends in the stretch. This plan is printed in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1884, pages 1137–1142. The estimated cost of all the work proposed was $38,800. On April 2, 1892, the plan was modified to provide for easing the worst points at the bends instead of making cut-offs. This work was completed on October 14, 1893, at three of the bends, the fourth being left until funds for making a cut-off should be provided. The amount expended was $4,695.71, and the balance of the appropriation, $304.29, reverted to the surplus fund in June, 1896.

The river and harbor act of June 13, 1902, appropriated $2,000 for maintenance of improvement at Volusia Bar, with the proviso that so much of this amount as may be necessary may be expended upon the St. Johns River between Volusia Bar (Lake George) and Lake Monroe, thus combining the previous projects. Thereafter dredging and snagging were done on the stretch from Lake George to Lake Monroe and the jetties at Volusia Bar kept in repair, maintaining a channel with a least depth of 5 feet at low water between Palatka and Sanford. The sum of $19,838 was expended in this work before the adoption of the present project.

7. OKLAWAHA RIVER, FLA.

The first provision for the improvement of this river was made by an act of Congress approved February 24, 1835, which appropriated $10,000 "for clearing out the Ochlawaha River from the St. Johns to Glassalls Spring, near Camp King, for the transportation of provisions and military stores to the garrison at that place, as estimated in the report of the Quartermaster General." Under this provision of law the sum of $3,911.95 was expended in 1835, and the balance of the appropriation was subsequently returned to the Treasury.

8. INDIAN RIVER, FLA.

The first project for improvement of Indian River was adopted by an act of June 15, 1844, which appropriated $1,500 for connecting Indian River with Mosquito Lagoon at the Haulover, thus opening the water route down the coast. A second appropriation of $5,000 was made for the same purpose in the river and harbor act of August 30, 1852. A total of $4,994.94 was expended in this work in 1853 and 1854, resulting in a cut 8 feet wide, with a depth of water of 2 feet.

The river and harbor act of August 18, 1894, made provision for dredging channel from the channel of the Indian River through the Negro Cut to the bar at the Indian River Inlet; and the river and harbor act of March 3, 1899, authorized the construction of a training wall for the protection of the dredged channel. This project was

Digitized by Google

based on report printed in Senate Document No. 3, Fifty-third Congress, second session, also in Annual Report for 1894, pages 1227–1230, which contemplated a channel 6 feet deep at mean low water and 100 feet wide. The estimated cost of the work, including dredging and the construction of a training wall to protect the dredged cut, was $32,775. The project was practically completed in January, 1902, at a cost of $32,500, which was $275 less than the estimate.

The deficiency act of February 26, 1896, made provision for opening Jupiter Inlet for the passage of boats and small vessels. A cut 40 feet wide and 2 feet deep at low water was made in September, 1896, at a cost of $500. In 1900 the inlet closed. It was reopened in 1901, at a cost of $1,000. The total expenditure on Jupiter Inlet was $1,500.

10. HARBOR AT MIAMI (BISCAYNE BAY), FLA.

The first appropriation for Biscayne Bay was made in the river and harbor act of March 3, 1899, which provided for the appointment of a board of engineers to examine the three routes from Miami to the sea with reference to the most feasible route and the cost of providing a channel 18 feet deep and of suitable width and the desirability of the improvement. The report of the board was submitted April 9, 1900, and is printed in House Document No. 662, Fifty-sixth Congress, first session. The sum of $4,965.51 was expended in this work.

The first project for the improvement of the bay was adopted by Congress in the river and harbor act of June 13, 1902, and was based on the report of the board of engineers printed in House Document No. 662, Fifty-sixth Congress, first session. The sum of $300,000 was appropriated and authorized for the improvement, with a view to obtaining a channel 18 feet deep from the wharves at Miami to the sea by way of a line entering the sea through a new cut about 4,000 feet north of Norris Cut, as described in the report printed in the document, and a basin of the same depth, 1,600 feet long, and 500 feet wide, adjacent to the wharves at Miami. The act provided that the Florida East Coast Railway Co. should construct at its own expense the basin adjacent to the wharves at Miami, and the channel across the bay to the east side of the refuge basin proposed in the report of the board, this channel to be not less than 85 nor more than 100 feet in width, as the Secretary of War might determine, and the channel and the basin to be open to the free and unobstructed use of the public. The work to be done by the United States with the funds appropriated and authorized was limited to constructing and protecting the portion of the channel extending to the sea from the terminus of the channel to be constructed by the railway company, of such approximately uniform depth and of such width as would best serve the interests of navigation and as could be constructed with the funds appropriated and authorized. The act provided further that before any part of the appropriation should be expended the said railway company should enter into a contract with the United States for the performing of its part of the work, and for securing in its portion of the channel and in the basin adjacent to the wharves practicable depths at least as great as are secured in the portion of the channel to be built by the United States, and for maintaining for

Digitized by Google

a period of three years, after the 18-foot channel to be constructed by the Government shall have been obtained, an equal depth in the basin and the channel across the bay. The contract was also required to contain certain provisions for the use of the railway wharves and other facilities by all shippers at reasonable rates and on just and reasonable conditions.

The project adopted by Congress, as above described, formed only a part of the plan prepared by the board of engineers, which contemplated an entrance channel 300 feet wide and 18 feet deep, increasing seaward to 20 feet, and protected by one or two jetties, as might be found necessary; a channel inside the entrance 200 feet wide and 18 feet deep leading to a refuge basin 1,200 feet long and 400 feet wide located at some convenient point near the entrance; and a channel 150 feet wide across the bay. The estimated cost of this work was $1,493,743, or $900,000 if the channel across the bay were omitted.

The project adopted in the act of June 13, 1902, was modified by Congress in the river and harbor act of March 2, 1907, which provided for dredging the Government's portion of the channel to a width of 100 feet and for constructing the north jetty. The sum of $246,000 additional was appropriated and authorized, thus increasing the amount allowed for the work to $546,000.

Under this project and its modifications two jetties were built and the entrance channel dredged through the rock and sand 18 to 20 feet deep and 110 feet wide for 2,410 feet and 85 feet wide for the rest of its length. The dredged channel rapidly shoaled to a limiting depth of 7 or 8 feet. Work ceased in August, 1911. The total expenditure under the project was $560,436.60, of which $548,483.27 was for original work and $11,953.33 was for maintenance.

11. HARBOR AT KEY WEST, FLA.

The improvement of the entrance to the harbor at Key West was inaugurated by Congress in the river and harbor act of August 2, 1882, which appropriated $25,000 for "Improving Key West Harbor, especially the Northwest Entrance." The improvement contemplated was that proposed in report of examination of harbor of Key West, Fla., printed in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1882, pages 1314–1315. The project provided for deepening the Northwest Entrance to 17 feet, the cut to be 300 feet wide, and the improvement to be effected by dredging, at an estimated cost of $140,000. Under this project $25,000 was expended in 1883 in dredging a cut 60 feet wide and 15 feet deep through the bar, but this cut was not permanent. By 1885 it had shoaled to the general depth of 11 feet. In the river and harbor act of August 5, 1886, $2,500 was appropriated for an examination and survey of the entrance. The entire appropriation was expended for this purpose, and a project for the improvement of the entrance was prepared, which contemplated the formation and maintenance of a channel 17 feet deep at mean low water, by means of a dike along its western side, the removal of a ledge of rock, and dredging, at an estimated cost of $607,600. (Annual Report for 1887, pp. 1221–1234.)

Digitized by Google

13. CALOOSAHATCHEE RIVER, FLA.

The first project for the improvement of this river was inaugurated by Congress in the river and harbor act of August 2, 1882, and was based on plans and estimates presented in a report of examination of the river printed in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1879, pages 863–870. The project contemplated a channel 7 feet deep at ordinary low water and 100 feet wide from the mouth to Fort Myers (14 miles), to be secured by dredging, at an estimated cost of $19,962. This project was completed in August, 1885, at a total cost of $9,456.59, which was $10,505.41 less than the original estimate.

A modification of this project was approved by the Chief of Engineers in April, 1887. This modification provided for the expenditure of $2,000 in making a thorough survey of the river and for the removal of snags and overhanging trees between Fort Myers and Fort Thompson, with a view to making the river navigable as far as Fort Thompson for boats drawing 4 feet. On September 15, 1888, a further modification of the project was approved, providing for dredging a channel 4 feet deep through the shoal at Beautiful Island (2 miles above Fort Myers) and the building of a training wall to protect the dredged cut. The contemplated expenditure in the work proposed was about $15,600. The modified project was recognized by Congress in the river and harbor acts of August 11, 1888, September 19, 1890, and June 13, 1902, by which funds were appropriated for completing and maintaining the improvement of the upper river. The project, as modified, was completed February 14, 1891, at a total cost of $17,993.17. The cost of maintenance was then estimated at $1,000 per annum.

15. CHARLOTTE HARBOR, FLA.

The improvement of this harbor was inaugurated by Congress in the river and harbor act of September 19, 1890, which appropriated $35,000 for improving, dredging, and deepening the channel of Charlotte Harbor and Pease Creek to the Florida Southern Railroad pier at Punta Gorda. A project for the expenditure of this appropriation in dredging a continuous 12-foot channel to the wharf at Punta Gorda, of such width as could be dredged with the funds available, was approved by the Chief of Engineers October 23, 1890. In 1891 an extension of this project was approved by the War Department, based on report of survey printed in Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1891, pages 1646–1651. This project contemplated securing a channel 200 feet wide and 12 feet deep at mean low water from the Gulf of Mexico to the railroad wharf at Punta Gorda, at an estimated cost of $127,500, the improvement to be effected by dredging through obstructing shoals in the harbor. In 1896 the estimate of cost was reduced to $100,000, and in 1897 the dredging was extended 4,600 feet to the new wharf of the Plant railway system (now the Atlantic Coast Line Railroad). This project was reported as practically completed December 23, 1899, at a total cost of $100,000. The channel was made 12 feet deep throughout and 200 feet wide, ex-

Digitized by Google

cept for the upper portion near the wharves, where the width was 160 feet and 120 feet, which appeared to be sufficient for the needs of commerce.

17. MANATEE RIVER, FLA.

The improvement of this river was inaugurated by the river and harbor act of August 2, 1882, and was based on report of examination printed in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1882, page 1319. This project contemplated a channel 100 feet wide and 13 feet deep from Tampa Bay to Shaws Point and thence to McNeills Point, a distance of 4 miles, to be obtained by dredging. The estimated cost was $70,000. In 1886 this project was modified by authority of the Secretary of War (Dec. 15, 1886) to provide for a channel 90 feet wide and 8 feet deep at mean low water from Tampa Bay to Rocky Bluff, a distance of 11 miles, and in 1887 this was changed to provide for a channel 100 feet wide and 8 feet deep from the bay to Manatee, a distance of about 8 miles. The work required by the latter modification was completed in 1889, with an expenditure of about $34,000, and in 1892, by authority of the Secretary of War (Aug. 13, 1892), the original project was resumed, the cost of completion being then estimated at $39,000.

By the river and harbor act of June 3, 1896, provision was made for a cut-off from the lower part of the river into Terra Ceia Bay. On June 23, 1897, a project for this cut-off was approved by the Secretary of War, providing for obtaining, by dredging, a channel 100 feet wide and 6 feet deep at mean low water from Manatee River to Terra Ceia Bay, at an estimated cost of $20,000. This cut-off was completed April 30, 1900, at a total actual cost of $13,342.

18. TAMPA BAY, FLA.

The first project for the improvement of Tampa Bay was adopted by Congress in the river and harbor act of June 14, 1880, which contained an appropriation for "deepening the bar and channel from the bar to the town of Tampa." The improvement contemplated was the project outlined in report of examination of Tampa Bay and the mouth of Hillsboro River, dated August 25, 1879, and printed in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1879, pages 870–873. This project provided for deepening the existing channel from deep water in the bay to Tampa, by dredging to 9 feet, making the channel 200 feet wide in the river and 150 feet wide in the bay, at an estimated cost of $97,002. All the work proposed was in what is now called Hillsboro Bay and in the mouth of the Hillsboro River, ample depths for the navigation then existing being found over the bar at the entrance and through Tampa Bay proper.

This project was modified by Congress in the river and harbor act of August 11, 1888, which provided for the improvement of the bay from the outer bar to Mangrove or Bushy Point. The improvement contemplated was that recommended by Capt. W. M. Black, Corps of Engineers, in his annual report for 1888 (Annual Report of Chief of Engineers for 1888, p. 1114). This project provided for limiting

Digitized by Google

the depth in the channel to the city of Tampa to the depth of 8 feet, already attained, and for connecting the deep water of Old Tampa Bay and Tampa Bay by dredging a cut 200 feet wide and 20 feet deep at low water through the shoals below Mangrove Point, at an estimated cost of $63,000, making a channel not less than 20 feet deep at mean low water and not less than 200 feet wide from the Gulf of Mexico to Port Tampa, the terminus of the South Florida Railway (now the Atlantic Coast Line Railroad) on Old Tampa Bay.

Between 1880 and 1892 a total of $130,000 was appropriated for work under this project and its modification. The work in Old Tampa Bay contemplated by the modified project was completed in May, 1892, at a cost of $50,000, which was $13,000 less than the original estimate. The rest of the $130,000 appropriated was expended in Hillsboro Bay under the original project.

20. HILLSBORO BAY, FLA.

The improvement of Hillsboro Bay was inaugurated by Congress in the river and harbor act of June 14, 1880, which appropriated $10,000 for improving Tampa Bay by "deepening the bar and channel from the bar to the town of Tampa." The improvement contemplated was that proposed in report of examination of Tampa Bay and the mouth of Hillsboro River, dated August 25, 1879, and printed in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1879, pages 870–873. This project provided for deepening the existing channel from deep water in the bay to Tampa by dredging to 9 feet, making the channel 200 feet wide in the river and 150 feet wide in the bay, at an estimated cost of $97,002. All the work proposed was in what is now called Hillsboro Bay and in the mouth of the Hillsboro River, ample natural depths for the navigation then existing being found on the bar and in Tampa Bay proper. In 1888, upon the recommendation of Capt. W. M. Black, Corps of Engineers, in his annual report for 1888 (Annual Report of the Chief of Engineers for 1888, p. 1114) this project was modified by limiting the depth in the channel in Hillsboro Bay and the mouth of the Hillsboro River to 8 feet, the depth already obtained. Work on this project, as modified, was suspended in June, 1893, after an expenditure of $80,000, appropriated under the title of "Improving Tampa Bay" and "Improving harbor at Tampa Bay." When work on this project ceased the channel was 200 feet wide in the river and from 75 to 100 feet wide in the bay, and from 8 to 9 feet deep throughout.

A second project was adopted by Congress in the river and harbor act of March 3, 1899, and was based on plans and estimates printed in House Document No. 545, Fifty-fifth Congress, second session. This project contemplated securing a channel 12 feet deep at mean low water in Hillsboro River, from a point about 100 feet south of the Lafayette Street Bridge to the mouth of the river, and thence along the line of shortest distance to the 12-foot contour in Hillsboro Bay, the width to be 200 feet in the river and 150 feet in the bay, at an estimated cost of $300,000 for construction and $1,000 annually for maintenance, the improvement to be effected by dredging in the bay and dredging and rock excavation in the river. This project, which included work in the Hillsboro River as well as in

Digitized by Google

the bay, was practically completed in 1905, when it became merged in the third project adopted that year. A total of $275,000 was expended under this project, all of which was for original work. The result was a channel 12 feet deep at mean low water from the 12-foot contour in the bay to a point 100 feet south of the Lafayette Street Bridge, the width being 200 feet in the river and 150 feet in the bay, except for a short distance where the width was but 110 feet. Of the total expenditure under this project $96,832.91 was expended in Hillsboro River.

A third project, for obtaining a depth of 20 feet from the lower bay to the mouth of Hillsboro River, was adopted by Congress in the river and harbor act of March 3, 1905, and was based on plans and estimates printed in House Document No. 306, Fifty-eighth Congress, second session. This project provided for a channel 20 feet deep at mean low water and 150 feet wide from the lower bay to the mouth of the Hillsboro River, with a turning basin 1,050 feet long and 450 feet wide at the inner end of the channel. The estimated cost was $448,350. The improvement was to be effected by dredging. This project was completed February 29, 1908, except for a small area in the northwestern end of the turning basin, where ledge rock was found, over which a least depth of 16.8 feet at mean low water was attained. The total expenditure under this project was $465,157.70, of which $448,050.46 was for original work and $17,107.24 was for maintenance after completion.

21. HILLSBORO RIVER, FLA.

The improvement of Hillsboro River was inaugurated by Congress in the river and harbor act of June 14, 1880, which appropriated $10,000 for improving Tampa Bay by "deepening the bar and channel from the bar to the town of Tampa." The improvement contemplated was that proposed in report of examination of Tampa Bay and the mouth of Hillsboro River, dated August 25, 1879, and printed in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1879, pages 870–873. This project provided for deepening the existing channel from deep water in the bay to Tampa by dredging to 9 feet, making the channel 200 feet wide in the river and 150 feet wide in the bay, at an estimated cost of $97,002. All the work proposed was in what is now called Hillsboro Bay and in the mouth of the Hillsboro River, ample natural depths for the navigation then existing being found on the bar and in Tampa Bay proper. In 1888, upon the recommendation of Capt. W. M. Black, Corps of Engineers, in his annual report for 1888 (Annual Report of the Chief of Engineers for 1888, p. 1114) this project was modified by limiting the depth in the channel in Hillsboro Bay and the mouth of the Hillsboro River to 8 feet, the depth already obtained. Work on this project, as modified, was suspended in June, 1893, after an expenditure of $80,000, appropriated under the title of "Improving Tampa Bay," and "Improving harbor at Tampa Bay." When work on this project ceased, the channel was 200 feet wide in the river and from 75 to 100 feet wide in the bay and from 8 to 9 feet deep throughout.

The second project was adopted by Congress in the river and harbor act of March 3, 1899, and was based on plans and estimates

Digitized by Google

printed in House Document No. 545, Fifty-fifth Congress, second session. This project contemplated securing a channel 12 feet deep at mean low water in Hillsboro River from a point about 100 feet south of the Lafayette Street Bridge to the mouth of the river, and thence along the line of shortest distance to the 12-foot contour in Hillsboro Bay, the width to be 200 feet in the river, and 150 feet in the bay, at an estimated cost of $300,000 for construction and $1,000 annually for maintenance, the improvement to be effected by dredging in the bay and dredging and rock excavation in the river. All work in the Hillsboro River contemplated by this project, which forms the basis of the present project for the Hillsboro River, was completed in March, 1905. The expenditure on this work is included in the expenditure reported under the head of Hillsboro Bay, the appropriations having been made under that title. The amount expended in the river under this project was $96,832.91.

25. WITHLACOOCHEE RIVER, FLA.

The first project for the improvement of this river was inaugurated by Congress in the river and harbor act of March 3, 1881, and was based on report dated March 6, 1880, of an examination of the river from its mouth to Hayes Ferry, printed in Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1880, pages 1110–1119. This project contemplated the removal of snags, overhanging trees, and loose rock and cutting through some of the worst shoals in the river and the bar at the mouth, with a view to making it possible for boats drawing 2 feet of water to navigate the river as far up as Hayes Ferry (79 miles)—extended in 1886 to Pembertons Ferry (85 miles)—during about one-half the year. The estimated cost of the work was $23,900. The project was practically completed November 14, 1892. The total expenditure was $24,403.62. The river and harbor act of June 25, 1910, provided for maintenance to Pembertons Ferry, and this old project may, therefore, be regarded as continued in force, except where superseded by later projects.

A project for deepening the channel at the entrance was adopted by the river and harbor act of June 13, 1902. This project provided for deepening the channel, previously dredged by private interests, from the mouth of the river to the loading pool in the Gulf of Mexico, a distance of 11,780 feet, to a depth of 8 feet, for straightening the channel, and for its maintenance. This project was practically completed in 1906 at an expenditure of $30,000, a channel with a least width of 60 feet and a least depth of 7.8 feet at low water being secured.

26. SUWANNEE RIVER, FLA.

The first provision for the improvement of this river was made by an act approved March 3, 1839, which appropriated $15,000 "for the removal of obstructions at the mouth of the Suwannee River and for the survey of said river with a view to its improvement." With these funds an accurate survey of the mouth of the river was made, and a report was submitted May 15, 1841, outlining a plan of improvement. The sum of $10,154.02 was expended in this work, and the balance of the appropriation, being considered insufficient to accomplish any useful improvement, was returned to the Treasury in 1841.

Digitized by Google

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE MONTGOMERY (ALA.) DISTRICT.

1. CARRABELLE BAR AND HARBOR, FLA.

The river and harbor act of August 5, 1886, provided that $2,000 of an appropriation made for Apalachicola Bay might be expended on Carrabelle (or Crooked) River. This was expended in 1887 in dredging a channel 1,604 feet long, 30 feet wide, and 8 feet deep at the mouth of the river. The river and harbor act of June 3, 1896, appropriated $10,000 to be used in securing a 10-foot channel from the mouth of Carrabelle River to the channel in the bay. (H. Doc. No. 328, 53d Cong., 3d sess.; Annual Report for 1895, p. 1680.) Under the provisions of this act a channel about 10,000 feet long and 53 feet wide was constructed, but still did not provide the project depth up to the city. A second appropriation of $10,000 was provided by the act of March 3, 1899, for continuing this improvement, and the work was continued until a channel with a depth of 8 feet and a width of 80 feet was obtained, the total expenditures being $21,704.08. A project for obtaining by dredging a channel 10 feet deep and 100 feet wide from Dog Island anchorage to the town of Carrabelle, at an estimated cost of $47,300, was adopted by the river and harbor act of June 13, 1902 (H. Doc. No. 227, 56th Cong., 2d sess.; Annual Report for 1901, p. 1800), which project was partially completed and remained in force until the present project was adopted. The expenditures upon the modified project were $28,554.75.

2. APALACHICOLA BAY, FLA.

The river and harbor act of June 14, 1880, adopted a project (Ex. Doc. No. 241, 42d Cong., 2d sess.; Annual Report for 1872, p. 612) for securing a channel 100 feet wide and 11 feet deep across the shoal at the mouth of Apalachicola River by dredging, at an estimated cost of $100,000, and subsequent acts down to and including that of June 3, 1896, made appropriations to carry out the project, the sum of $154,000 being expended. The act of August 5, 1886, however, provided that $2,000 of the sum appropriated by that act should be expended at Carrabelle. (Annual Report for 1887, p. 1265, and 1888, p. 1161.) In 1890 it was reported that Bulkhead Shoal, separating Apalachicola Bay and St. Georges Sound, had become the most serious obstruction to the commerce of Apalachicola Bay, and it was recommended that a channel not less than 9 feet deep and not to exceed 100 feet wide be dredged through that shoal. This recommendation was approved by the Chief of Engineers May 20, 1891, and the work was carried out in the following year, the cost of this work being included in the sum given above. The river and harbor act of March 3, 1899, adopted a project for obtaining a channel 18 feet deep and 100 feet wide from the Gulf of Mexico to the town of Apalachicola. (H. Doc. No. 129, 54th Cong., 2d sess.; Annual Report for 1897, p. 1655.) The estimate of the cost of the work was placed at $350,000 for the proposed improvement and $20,000 to $30,000 annually for maintenance. This project continued in force until

Digitized by Google

1907, when it was superseded by the present project. The expenditures on this modification were $130,679.26.

6. CHATTAHOOCHEE RIVER, GA. AND ALA.

BELOW COLUMBUS, GA.

The river and harbor act of September 19, 1890, directed an examination and survey of the Chattahoochee River, Ga. and Ala., between West Point and Franklin, Ga. (H. Doc. No. 134, 51st Cong., 2d sess., and Annual Report for 1891, p. 1756.) Although the district officer's report was favorable to the improvement it was disapproved by the division engineer and the Chief of Engineers. The district officer's opinion was that the cost of the work, which would include one lock and dam, would be about $100,000. Congress adopted the project by making an appropriation of $5,000 in the act of July 13, 1892, and appropriations were continued on this section of the river from 1892 to 1899. The act of March 3, 1899, directed that a survey be made of that portion of the river between West Point and Franklin to determine the desirability of continuing the improvement. (H. Doc. No. 111, 56th Cong., 2d sess., and Annual Report for 1901, p. 1793.) The report was unfavorable to the continuation of the improvement of this portion of the river, and it was abandoned pursuant thereto.

9. CHOCTAWHATCHEE RIVER, FLA. AND ALA.

An act of Congress approved March 2, 1833, made an appropriation for the improvement of this stream as recommended by the Postmaster General. There is no record of the results obtained in this improvement, however. The river and harbor act of June 15, 1844, also made an appropriation for improving the Choctawhatchee and Holmes Rivers, of which no record of results obtained exists in this office. Of these appropriations $12,876.62 were expended in this stream. The river and harbor act of June 14, 1880, adopted a project (Annual Report for 1880, p. 1081) for the improvement of the river between Geneva and Newton, Ala., by the construction of three timber locks to cover the section of the river immediately below Newton, Ala., estimated to cost $45,000, and provided for snagging, etc., from Newton to Geneva, Ala., all at an estimated cost of $78,500. The locks were never constructed. Snagging and other work were carried on at a cost of $24,373.86 prior to the adoption of the present project.

12. BLACKWATER RIVER, FLA.

The river and harbor act of March 3, 1899, adopted a project for the improvement of Blackwater River from Milton to the mouth, for a channel 9 feet deep and 100 feet wide, to be obtained by dredging at Hunts Bar within the river, and at the shoalest points within the bay, at an estimated cost of $20,000. (S. Doc. No. 11, 47th Cong., 1st sess.; Annual Report for 1882, p. 1309.) Dredging was done at Hunts Bar under this project. A part of the work contemplated in the above project was not done due to improvement of the channel by natural causes when a portion of the project as above outlined was accomplished. (Annual Report for 1900, p. 2128.)

Digitized by Google

13. HARBOR AT PENSACOLA, FLA.

The river and harbor act approved June 18, 1878, made an appropriation of $20,000 for the improvement of the harbor, including a survey and estimate for the removal of wrecks. Pursuant to this requirement of the law a portion of the appropriation was expended in the removal of certain wrecks in the harbor and the remainder in making a survey and preparing a project for the improvement of the harbor at a cost of $16,901.93. (Annual Report for 1879, p. 801.) It was reported that the shoals mentioned in Coast Survey chart of 1859 as Middle Ground and Caucus Shoals were found to have joined across the main ship channel, forming an inner bar with an available depth across it of only 18 feet at mean low tide where formerly there had been 30 feet. It was also reported that the shore on the western side of the entrance extending north and south from Fort McRee had washed away considerably so that the general direction of the shore had materially changed. No consideration was taken in this report of the outer bar. The district officer suggested that the project for improvement should include the reestablishment of the old shore line so far as might be necessary to restore the former direction of the tidal currents, and that the channel across the inner bar should be dredged to a width of 300 feet and a depth of 24 feet to give relief to the commerce of the port; the reestablishment of the old shore line to be accomplished by building a training wall of brush and stone along its approximate former location to form the west line of the entrance. The estimate of the cost of this improvement was given as $177,250. Congress continued to make appropriations in succeeding river and harbor bills for this work, which was carried out along the lines proposed in this project. Work was continued thereunder until the project was further modified by the act of August 18, 1894, the sum of $330,574.75 being expended on this modification.

Meanwhile the act of July 5, 1884, provided for an examination and survey of the outer and inner bars at the entrance to Pensacola Harbor. (H. Doc. No. 224, 48th Cong., 2d sess.; Annual Report for 1885, p. 1316.) The district officer reported that the Coast Survey chart of 1857 showed a depth of 3¾ fathoms, or 22½ feet, over the outer bar; the survey made in 1884 showed 22 feet over the bar; and that the recent examination showed a scant 22 feet over it. The bar remained approximately constant in position and had the same depth over it as previously reported. He reported that it would be necessary to maintain it by continuous dredging or by expensive work of contraction, and that he considered the excavation of a channel 24 feet deep at mean low water and 300 feet wide across the bar to be too hazardous to be undertaken. He further reported that the work of contraction to maintain this depth over the outer bar should not be undertaken before the difficulty of the inner bar had been overcome. He recommended that the work of dredging a channel across the inner bar be completed and that the shore line at Fort McRee be gradually advanced under the existing project, which he estimated could be done for the sum of $48,200. This examination recommended no modification of the existing project for the improvement of the locality. The work at Fort McRee was carried out as recommended. The condition of the bars having become such that relief was necessary, the district officer was directed by letter from the

Digitized by Google

office of the Chief of Engineers dated March 29, 1890, to submit a report on the condition of the outer bar with estimate of cost to obtain the required depth by dredging. This examination was made in April, 1890, which showed the least depth on the outer bar to be 22.1 feet at mean low water and on the inner bar 19.6 feet. The district officer reported that it would require $106,446 to dredge a channel 22 feet deep and 300 feet wide through the inner and outer bars.

The final report on this survey was submitted on January 7, 1891, which report was then referred to a board of engineers, whose report, dated July 16, 1891, will be found printed, together with other reports, in the Annual Report of the Chief of Engineers for 1891, page 1713. The board submitted a project for obtaining a channel 300 feet wide and 24 feet deep by the construction of two converging jetties, at an estimated cost of $1,830,400, of which $250,000 was to be used in supplementing the effect of the jetties by dredging. The river and harbor act approved August 18, 1894, made an appropriation of $100,000 for this improvement, and provided that the Secretary of War might, if he deemed it advisable, begin the improvement recommended by the board of engineers appointed in January of 1891 to consider and report upon the improvement of this harbor. Preparations were made to begin work under this project by the drawing up of plans and specifications for work to be done by contract. In the meantime dredging operations had been carried on from time to time, which resulted in a depth of 21 feet at average tide. In his annual report for the year 1894 the district officer set forth previous experience on this work with dredging, and recommended that a new channel be dredged across the Caucus Shoal and also recommended that the Government have built for service at this harbor a suitable dredge for the use of the locality. In his report for the following year the district officer further modified his recommendations so as to provide that the project be amended to omit the construction of the jetties and to place entire reliance upon dredging, recommending the construction of a suction dredge and opening a channel through Caucus Shoal to have a width at the bottom of 300 feet and a least depth of 30 feet, following the line of ebb currents. (Annual Report for 1895, p. 1634.) This report was again referred to a board of engineers, whose report will be found printed on page 1657 of the Annual Report of the Chief of Engineers for 1895. This board recommended that the experiment of obtaining a channel by dredging be tried and that the district officer be directed to take the necessary steps to secure immediately the use of a hydraulic dredge to open a channel 26 feet deep at mean low water and as wide as practicable on the line of deepest water across Caucus Shoal approximately on the line of the axis of the jettied channel of 1891, which recommendation was approved August 26, 1895. A dredge having been secured, work was continued on this project until it was further modified. The river and harbor act of March 3, 1899, made an appropriation for continuing improvement and for maintenance to be used toward securing a channel depth of 30 feet at mean low water from the Gulf of Mexico to the dock line at the east end of the city of Pensacola. Up to this time there had been opened a new channel across the Caucus Shoal, with a width of 150 feet and a depth of 24 feet at mean low water. Work was continued on this project, mainly under contract, until the present project was adopted.

Digitized by Google

14. ESCAMBIA AND CONECUH RIVERS, FLA. AND ALA.

The river and harbor acts of March 2, 1833, and July 2, 1836, made appropriations for removing obstructions and making navigation in the Escambia River to the amount of $10,500, of which $5,000 was expended. This office has no record of the results obtained from the work authorized. The river and harbor act of June 18, 1878, directed an examination and survey of the Escambia and Conecuh Rivers. (Annual Report for 1879, p. 852, Escambia River; p. 843, Conecuh River.) The district officer, in the case of the Conecuh River, presented a project for the opening of the river to facilitate timber transportation by the removal of snags, closing three cut-offs, and the construction of some wing dams at a cost of $62,430. The work was carried out practically as recommended and was maintained until the present project for Conecuh River was adopted.

15. ALABAMA RIVER, ALA.

The river and harbor act of March 3, 1875, provided that an examination and survey be made of the Alabama River from Wetumpka to its mouth. The original project for improvement of this river (Annual Report for 1876, p. 498) was to obtain a width of channel of 200 feet and a depth of 4 feet at an estimated cost of $229,741. It was authorized by act of Congress approved June 18, 1878, making an initial appropriation of $25,000 for beginning work under this project. Work thereunder was continued until 1892, when it was reported that the project had been practically completed, $177,985.78 being expended thereon. The river and harbor act of July 13, 1892, extended the project to include securing a 6-foot channel at low water from the mouth to Wetumpka (H. Doc. No. 140, 51st Cong., 2d sess.; Annual Report for 1891, p. 1761) at an estimated cost of $386,251 for improvement and including $10,000 annually for maintenance. Under this project a depth of about 4 feet at mean low water was secured at a cost of $241,459.91.

16. COOSA RIVER, GA. AND ALA.

The river and harbor act approved July 11, 1870, contained a provision directing an examination and survey to be made of the Coosa River, Ala. Pursuant to this provision of law a survey was begun at Wetumpka on September 13, 1870, and was continued until the 27th of December, reaching what was known as the Selma, Rome & Dalton Railroad bridge across Coosa River, now the Selma-Rome branch of the Southern Railway, near Wilsonville, Ala., when operations were suspended on account of high water. (Annual Report for 1871, p. 561.) In addition to the survey to the railroad bridge a reconnoissance was made of the portion of the river from the bridge to Greensport, Ala., and an estimate was submitted of the amount of work required and the cost thereof to remove the obstructions to navigation in the Coosa River between Greensport, Ala., and the point where the Selma, Rome & Dalton Railroad crosses the river some 77 miles below. The estimated amount was $278,484.50, and provided for the construction of locks and dams at Whistenants Mill Shoal, Ten Island Shoal, Box Shoal, and the construction of dams at

Digitized by Google

Broken Arrow Shoal, Chocolocco Shoal, Long Shallow Beach, Claunchys Shoal, Turners Mill Shoal, and rock excavations at various other points. No estimate appears to have been submitted in this report for the section of the river between Wetumpka and the Selma, Rome & Dalton Railroad bridge at this time. Os March 23, 1872, a further report was submitted on this improvement under the provision of law above cited. This report provided for the construction of locks and dams from Wetumpka to the Selma, Rome & Dalton Railroad bridge at an estimated cost of $1,923,020. (Annual Report for 1872, p. 502.) On August 20, 1872, a further report was submitted under the same provision of law on that portion of the Coosa River between the railroad bridge and Greensport. (Annual Report for 1872, p. 536.) In this report a revised estimate is submitted of the cost of work and the amount required to open steamboat navigation on the Coosa River between the Selma, Rome & Dalton Railroad bridge and Greensport, Ala., 74 miles above. This estimate provides for locks and dams at Turners Mill Shoal, at Chocolocco Shoal, at Broken Arrow Shoal, at Ten Island Shoal, and at Whistenants Mill Shoal, together with rock and gravel excavation at various other points. The total estimated cost of the improvement over this section of the river was $470,668.

In addition to these examinations of the Coosa River as directed by the act of 1870, the act of March 3, 1871, directed a survey from the Tennessee River to the headwaters of the Warrior and Coosa Rivers with a view to uniting the waters of the Tennessee and Coosa Rivers for navigation purposes. Under this authority an examination was made of the Coosa River between the mouth of Wills Creek, the terminus of the proposed canal from the Tennessee River and Rome, Ga. (Annual Report for 1875, vol. 2, p. 661.) This report provides for the construction of a lock and dam at Horseleg Shoal, below Rome, Ga., and for open-channel work from that point to the mouth of Wills Creek, the estimated cost of the improvement being $180,000, the dimensions of the lock to be 200 feet between miter sills and 32 feet wide and to have a lift of 3 feet. The river and harbor act approved August 14, 1876, appropriated $30,000 for the improvement of the Coosa River, Ga. and Ala., by the construction of a lock and dam at Horseleg Shoal, the improvement of the river from Rome, Ga., to Greensport, Ala., by open-channel work, the construction of locks and dams at Whistenants Shoal, at Ten Island, at Box Shoal, at Broken Arrow Shoal, at Chocolocco Shoal, at Long Shallow Beach, and at Claunchys Mill Shoal and Turners Mill Shoal at an estimated cost of $650,668. The estimated cost of improving the section of the river from Rome, Ga., to the mouth of Wills Creek, including the construction of the lock and dam at Horseleg Shoal, was $180,000, and $470,668 for improving that part of the river between Greensport and the Selma, Rome & Dalton Railroad bridge, no estimate having been submitted to cover that portion of the river between Greensport and the mouth of Wills Creek. In 1877 work was begun under this project near Rome, Ga., at Horseleg Shoal and was continued down the river, while in 1878 plans were developed for Locks Nos. 1, 2, and 3 at Whistenants Mill Shoal and Ten Island Shoals. Appropriations were made for the work from time to time, and it was carried on so as to provide an

Digitized by Google

open river channel from Rome to Greensport. Locks Nos. 1, 2, and 3 were constructed. Dam No. 4 was begun in 1886, the dam being completed, but work on the lock was suspended on account of poor foundations and lack of funds.

The acts of 1880, 1881, 1884, and 1888 appropriated money for continuing the work below Rome and Locks Nos. 1, 2, and 3 and Dam No. 4. The act of 1888, however, provided that the Secretary of War should cause a survey to be made for a channel in and along the Coosa River from the rapids at Wetumpka to connect with the improvement already completed on the river above Ten Islands. It is also directed that a report be made as to the most feasible and economical plans for the improvement. (Annual Report for 1890, vol. 2, p. 1658.) The estimated cost of the improvement by locks and dams, supplemented by channel work, was $6,074,913, of which sum $968,491 applies to that section of the river above the East Tennessee, Virginia & Georgia Railroad bridge (formerly the Selma, Rome & Dalton Railroad). It provided for the construction by this sum of a lock in Dam No. 4, at Broken Arrow Shoals, and the construction of Locks and Dams Nos. 5, 6, 7, and 8, which would bring the improvement of the upper portion of the river to its lower limit. The remainder of the estimate covered the river from the railroad bridge to navigable water at Wetumpka. The act of September 19, 1890, provided for continuing the new project between Rome and East Tennessee, Virginia & Georgia Railroad bridge, and also adopted the project contained in the same report for improving the river between Wetumpka and the said bridge, the work being required to commence at the Wetumpka end and the size of the proposed locks being limited to a width of 40 feet and a length of 210 feet. (NOTE.—This provision, however, was later repealed by the act of July 13, 1892.)

The improvement of the river under these two projects was further authorized by acts of July 13, 1892, August 18, 1894, and June 3, 1896. Subsequent to 1896 appropriations for lock and dam constructions were omitted for several years, and the act of March 3, 1899, being the first subsequent act which authorized the expenditure of any money on this stream and the appropriation contained therein being limited to maintenance and deepening channel over shoals between Rome and the East Tennessee, Virginia & Georgia Railroad bridge. On the lower portion of the river, under this project, Locks and Dams Nos. 9 to 31, inclusive, were to be constructed. Pursuant to the requirements of the act of 1890, the construction of Lock No. 31, located at Wetumpka, was undertaken first and completed, except for the valves, gates, and operating mechanism. No dam was constructed. A considerable amount of excavation was done in the channel between No. 31 and proposed No. 30 above, and surveys and plans were made for Locks and Dams Nos. 9 and 10, but the work was abandoned before any further construction was undertaken; $404,943.66 was expended on this section of the river.

The act of June 13, 1902, appropriated the sum of $35,000 for the Coosa, Oostanaula, and Coosawattee Rivers and directed that $10,000 be deducted from appropriations made for the section of the river below the railroad bridge and be spent on the section above the

Digitized by Google

bridge. The said act further directed that a survey of the Coosa and Alabama Rivers be made with a view to securing a depth of 6 feet and determining the probable expense thereof, and directed a report as to the advisability of further prosecuting the lock and dam project on this stream. (Annual Report for 1905, p. 1351.) The report stated that a 6-foot navigation could be obtained on the river from Gadsden, Ala., to the mouth below Wetumpka at a cost of $11,024,706, and stated that in the opinion of the district officer it was not advisable to further prosecute the present project for locks and dams on the Coosa River, further than to complete Lock No. 4 and to construct a dam at site No. 5, a short distance below Riverside. The view was concurred in by the Chief of Engineers and the division engineer. Congress apparently coincided in this view, as no further appropriations were made except for maintaining the river between Rome, Ga., and Lock No. 4, for the completion of Lock No. 4, and the construction of Dam No. 5, the acts of March 3, 1905, and March 2, 1907, being limited to continuing the improvement and maintenance between Rome and Lock No. 4. The following tabulation shows the interrelation of the various estimates:

Item.	Miles.	Estimate.	Where found.
Rome-Wills Creek	108.5	$180,000	Annual Report, 1875, vol. 2, p. 661.
Wills Creek-Whistenant (Greensport-Lock No. 1).	20.5	(1)	
Lock No. 1-Dam No. 4, inclusive		[2] 181,599	
Dam No. 4-East Tennessee, Virginia & Georgia R. R. bridge.	48.0	470,668 269,069 968,491	Annual Report 1872, p. 536.
East Tennessee, Virginia & Georgia R. R. bridge-Wetumpka.	68.0	[3] 6,074,913 5,106,422	Annual Report 1890, p. 1658.
Lock in Dam No. 4	10.0	282,000	H. Doc. No. 1421, 60th Cong., 2d sess.
Dam No. 5		134,000	Do.
Lock and dam at Mayos Bar	6.5	[4] 241,039	H. Doc. No. 1115, 60th Cong., 2d sess.

[1] None made.
[2] Work provided for in this estimate not begun before work under subsequent estimate was authorized.
[3] Replaced former estimate for this section.
[4] Act of Mar. 2, 1907, ordered a survey for lock and dam at Horseleg Shoals, but the site recommended was at Mayos Bar.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE MOBILE (ALA.) DISTRICT.

1. MOBILE HARBOR, ALA.

The improvement of the channel of Mobile Harbor has been progressive. Between 1826, the date of the first appropriation for this work, and 1857 a channel 10 feet deep was dredged through the shoals in Mobile Bay up to the city of Mobile. Between 1870 and 1876 this depth was increased to 13 feet, the channel being dredged to a width of 300 feet through Choctaw Pass and 200 feet through Dog River Bar. In 1880 a project for a channel 17 feet deep at mean low water and 200 feet wide was adopted, and appropriations between 1878 and 1886 were applied to the formation of a channel of these dimensions. In the river and harbor act of August 11, 1888, a

Digitized by Google

project for securing a channel 23 feet deep at mean low water was adopted, this project being modified by the river and harbor act of September 19, 1890, so as to provide for the formation of a channel 23 feet deep and with a top width of 280 feet from the Gulf of Mexico to the mouth of Chickasaw Creek, above the city of Mobile. Work upon this channel was completed in 1896, subsequent appropriations, up to and including that made by the sundry civil act of July 1, 1898, having been applied to its maintenance. The total amount expended on these projects was $3,648,630.60, of which about $115,000 is estimated to have been applied to maintenance.

The next project for the improvement of Mobile Harbor was that adopted by the river and harbor act of March 3, 1899, and provided for the formation of a channel 23 feet deep and 100 feet wide at bottom, with appropriate side slopes, from the entrance of the bay to the mouth of Chickasaw Creek. Work on this project continued until its virtual completion on July 12, 1909. The act of June 13, 1902, made the removal of sunken obstructions part of the maintenance work in Mobile Harbor. The total amount expended on the above project was $1,896,860.58, of which $610,832.07 was applied to work of maintenance.

3. BLACK WARRIOR, WARRIOR, AND TOMBIGBEE RIVERS, ALA.

Other than the present project, there has been no single project applicable to the entire length of the river covered by the above designation. Prior projects for the individual streams comprising this improvement may be stated as follows:

Black Warrior River.—The name Black Warrior was formerly applied to that portion of the river above Tuscaloosa. On this section of the river the first project was that of 1887, which, by act of June 13, 1902, was merged with projects for the Warrior and Tombigbee Rivers, forming, with successive extensions and modifications, the present general project.

Warrior River.—The name Warrior River was formerly applied to the portion of the river from Tuscaloosa to Demopolis, and the original project for its improvement was adopted by the river and harbor act approved March 3, 1875, which provided for deepening the channel by jetty construction and removal of snags and overhanging trees. The amount expended under this project between the years 1880 and 1899, prior to the adoption of the project dated March 3, 1899 (which on June 13, 1902, was merged with projects for the Black Warrior and Tombigbee Rivers), was $319,388.30. In addition to the above expenditures, there have been expended on the Warrior and Tombigbee Rivers, jointly, appropriations aggregating $88,000, authorized as follows:

Mar. 3, 1875, improvement of the Black Warrior River below Tuscaloosa and Tombigbee below Demopolis	$25,000
Aug. 14, 1876, improvement of Warrior and Tombigbee Rivers	15,000
June 18, 1878, improvement of Warrior and Tombigbee Rivers	28,000
Mar 3, 1879, improvement of Warrior and Tombigbee Rivers	20,000

Tombigbee River, Ala.—The section of this river included in the improvement under discussion extends from Demopolis to the junction with the Mobile River, 45 miles above Mobile. There have been

Digitized by Google

no prior projects for its improvement other than that under which the $88,000 mentioned above under the Warrior River was expended.[1]

The above projects, involving a total expenditure of $407,388.30, are the only prior projects applicable to any of the streams under this improvement, and have been so regarded in annual reports.

4. TOMBIGBEE RIVER, ALA., FROM MOUTH TO DEMOPOLIS (MAINTENANCE OF CHANNEL).

The original project for the improvement of this section was adopted in 1871, and contemplated the removal of snags and other obstructions in the channel of river and the widening and deepening of the existing channel through various shoals, at an estimated cost of $21,500. This project was completed in 1873, at a cost of $5,332.95 for improvement.

The project adopted in 1879 was to afford a channel of navigable width and 4 feet depth at ordinary low water from the mouth to Demopolis, Ala., a distance of 185 miles, by the removal of snags, logs, and overhanging trees and the improvement of the worst bars by dredging. Under this project $60,209.53 was expended for improvement.

The earlier projects for the improvement of this section of the Tombigbee River was superseded by the project adopted in the river and harbor act of September, 1890, which provided for securing a channel 6 feet deep at low water between the mouth and Demopolis by the construction of locks and dams, bank revetments, and by the removal of logs, snags, and other obstructions. The cost of this project was originally estimated at $508,808.98, but in 1897, after $330,000 had been appropriated for the work, the estimate increased, the additional cost of completion being then placed at $600,000. Under this project $134,000 was expended for improvement and $50,000 for maintenance, exclusive of lock and dam construction, which was merged with project of 1902, succeeding.

Prior to the adoption of this project of 1902, for maintenance $249,542.48 had been expended on previous projects.

5. TOMBIGBEE RIVER, FROM DEMOPOLIS, ALA., TO WALKERS BRIDGE, MISS.

Formerly this section was operated as four separate improvements—Demopolis to Vienna, Vienna to Cotton Gin (or Amory), Columbus to Fulton, and Fulton to Walkers Bridge. It was subsequently combined into two improvements—Demopolis to Columbus and Columbus to Walkers Bridge—and these two have since been combined into one improvement, Demopolis to Walkers Bridge. The original project of 1871 contemplated the improvement of this stream between Demopolis and Columbus, a distance of 149 miles, by the removal of snags and other obstructions and by the widening and deepening of the existing channels through various bars. In 1879 this project was modified so as to provide for the formation of a

[1] Under another project, known as "Improving Tombigbee River, Ala. (mouth to Demopolis)," may be found record of prior projects for this portion of the river, but as these have no connection with the work of the improvement under discussion, they are not mentioned here.

Digitized by Google

channel of navigable width and 3 feet depth at low water from Demopolis to Columbus.

The project for the improvement of the river above Columbus was adopted in 1873, and provided for obtaining a good high-water channel by the removal of obstructions at an estimated cost of $35,000. This project was completed in 1882 at a cost of $27,293.65, since which time operations have been directed toward maintenance, this being the existing project.

The project for the improvement of the river from Fulton to Walkers Bridge, a distance of 25 miles, was adopted in 1888, and provided for securing a high-water channel by removal of logs, snags, and overhanging trees. It was completed in 1891 at a cost of $6,517.19, since which time operations have been directed toward maintenance, this being the existing project.

By department indorsement, dated April 14, 1911, work on this river is now restricted to improvement at and below Aberdeen, Miss., a distance of 199 miles above Demopolis. Prior to the adoption of the existing project $63,382.98 was expended on the section between Demopolis and Columbus.

8. PASCAGOULA HARBOR, MISS.

Appropriations were made for improving Pascagoula River at its mouth in 1827, 1828, and 1832, but there is no record of the work accomplished with those funds. The amounts appropriated in 1878 to 1879 were for improving Pascagoula River, Miss. The first definite project for the improvement at the mouth of this stream was adopted by the river and harbor act of June 14, 1880. This act was based on the report of an examination of this locality, made in compliance with the river and harbor act of June 18, 1878, and contained in House Document No. 95, Forty-fifth Congress, third session. It contemplated securing a channel 7 feet deep and 200 feet wide across the bar at the mouth of the river by dredging, the construction of certain wing dams and jetties, and the removal of snags and overhanging trees from the river above at a cost of $57,292.40. The dredging was estimated to cost $17,400. At the mouth of the river the project was practically completed in March, 1882, by the formation of a channel 7½ to 8 feet deep and from 180 to 190 feet wide. Snagging work under this project was prosecuted between June, 1882, and December, 1884, with the following results: From the mouth to a point 50½ miles above, project completed; from the latter point to the junction of the Leaf and Chickasahay Rivers, project was partially completed, logs and stumps removed, but no bank work done.

The amount appropriated and expended on these works from June 18, 1878, to July 1, 1885, is as follows:

Appropriated	$59,000.00
Expended	58,430.84
Balance	569.16

The total amount expended from the date of the first appropriation in 1827 was $74,500.

A new project was adopted by the river and harbor act of August 5, 1886, which provided for securing a channel of navigable width

Digitized by Google

and a minimum depth of 12 feet from Moss Point to the anchorage in Mississippi Sound, at an estimated cost of $78,100, and maintaining the river above Moss Point in its improved condition at an estimated cost of $2,500 per annum. From the date of the adoption of this project to June 3, 1896, the following appropriations were made:

Aug. 5, 1886	$20,000
Aug. 5, 1886 (transferred amount appropriated for improving Horn Island Pass, act July 5, 1884)	5,000
Aug. 11, 1888	27,000
Sept. 19, 1890	20,000
July 13, 1892	20,000
Aug. 17, 1894	13,000
June 3, 1896	6,000
Total	111,000

Under this project a channel was formed having a depth of 12 feet over a width of 80 feet from Moss Point to the mouth of the river, and a channel of 12 feet deep over a width of from 80 to 120 feet was dredged from the mouth of the river to a point in Mississippi Sound 10,072 feet beyond, thus partially completing the project. In order to reach the 12-foot contour this channel would have had to extend 8,826 feet farther. From March 2, 1827, to June 30, 1897, appropriations amounting to $200,500 had been made, and expenditures during this time, exclusive of sums spent for snagging, amounted to $161,817.60.

The river and harbor act of March 3, 1899, adopted another project for the improvement of Pascagoula River, which provided for the formation of a channel 12 feet deep from a point in the Dog River 3 miles above its mouth down the Pascagoula River to the 12-foot contour in Mississippi Sound, the width of channel to be 150 feet above and 300 feet below the Louisville & Nashville Railroad bridge at Pascagoula, Miss. The estimated cost was $317,600, including the removal of certain shoal spots in the Horn Island anchorage.

Work under this project was in progress between September, 1899, and February, 1902, during which time an uninterrupted 12-foot channel was obtained within the limits of the project in Pascagoula River, while a 20-foot channel was formed through the shoal areas in Horn Island anchorage. The sum of $304,364.36 was expended on this project to June 30, 1902, no portion of which was applied to maintenance.

The river and harbor act of June 13, 1902, modified and extended this project so as to provide for a channel 17 feet deep instead of 12 feet from 3 miles above the mouth of Dog River to Mississippi Sound at a total cost of $1,050,222, exclusive of the Horn Island improvement. The river and harbor act approved June 25, 1910, further modified the project for this improvement by extending the upper limit about 1 mile farther up Dog River, increasing the total cost of the project by $8,000. With subsequent modifications this project provided for a channel 17 feet deep and 150 feet wide from a point on Dog River 4 miles above its mouth down Dog River and Pascagoula River to the railroad bridge at Pascagoula, Miss. (formerly Scranton), thence 17 feet deep and 300 feet wide to the deep water in Mississippi Sound. As thus modified this channel was completed above the railroad bridge at Pascagoula and completed to

Digitized by Google

its project depth over a width of 225 feet below this bridge in 1910 at a total cost of $302,097.25. The sum of $358.582.65 has since been expended in maintaining this project, but no attempt has been made to obtain the full project width of 300 feet in Mississippi Sound. The depth of the channel across the bar at Horn Island through natural causes increased from 14 or 15 feet in 1853 to about 18 feet in 1886. Since the latter date this channel has been available for vessels up to a draft of slightly less than 18 feet at mean low water.

Under the appropriation for improving Pascagoula River, Miss., carried by the river and harbor acts of August 18, 1894, and June 3, 1896, provision was made for the removal of the bar in Horn Island Pass. In conformity with this provision a channel with a least depth of 19.5 feet referred to the existing datum and with a width of 200 feet was dredged through the Horn Island Bar, but the benefit of the improvement was soon lost through shoaling. The total cost of this work was $7,682.40. Under the appropriations for Pascagoula River and Horn Island Pass carried by the river and harbor act of March 3, 1899, and the sundry civil act of June 6, 1900, an amount estimated at $88,000 was between 1899 and 1901 applied to dredging a 20-foot (19 feet present datum) channel at certain shoal areas in the Horn Island anchorage basin.

The last project for the improvement of Horn Island Pass provided for the formation of a channel 21 feet deep at mean low water, 300 feet wide through the outer bar, and 200 feet wide elsewhere in the pass at an estimated cost of $40,480 and $9,000 annually to preserve the improvement. This project was adopted by the river and harbor act of March 3, 1905, which carried an appropriation of $40,480 for the work. The project was completed by the U. S. dredge *Charleston* in 1907. Work since that date has been for maintenance only. Of the amount spent on the Horn Island Pass improvement $136,162.40 was expended for new work and $36,475 for maintenance.

9. PASCAGOULA, LEAF, AND CHICKASAHAY RIVERS, MISS.

PASCAGOULA RIVER ABOVE THE MOUTH OF DOG RIVER.

The original project for this river was adopted in 1880, and in addition to providing for dredging work at the mouth (for which see report on Pascagoula Harbor, Miss.), contemplated improvement of the river above by the removal of snags and overhanging trees. Under this project the river was cleared of obstructions between 1882 and 1884 at a cost of $15,000, since which time funds have been applied to maintenance under existing project adopted in 1886. Report of the examination on which the original project was based is printed in the Annual Report of the Chief of Engineers for 1879, page 835.

CHICKASAHAY RIVER.

The original project for this stream was adopted by the river and harbor act of September 19, 1890, and provided for obtaining a high-water channel from the mouth to Shubuta, Miss., a distance of 130 miles, by the removal of obstructions from the channel and overhanging trees from the banks. The river and harbor act of

Digitized by Google

June 3, 1896, modified this project by limiting the improvement to that part of the river between the mouth and Bucatunna, Miss., about 75 miles. The project further provided for the maintenance of the improved channel, and, as modified, was completed in the latter part of 1896 at a cost of $12,399.73, of which $328.83 was for maintenance.

The project was based on an examination made in 1888, report of which is printed in the Annual Report of the Chief of Engineers for 1889, page 1463.

10. BILOXI HARBOR, MISS.

The original project was adopted by the river and harbor act of August 2, 1882, and contemplated the formation of a channel through Deer Island Flats to connect Biloxi Bay with the Back Bay of Biloxi, at an estimated cost of $35,000. The channel thus proposed was to have a depth of 8 feet at mean low water, no width being mentioned. No work was ever done under this project.

11. GULFPORT HARBOR AND SHIP ISLAND PASS, MISS.

There has been no previous project for Ship Island Pass. The original project for Gulfport Harbor was adopted by the river and harbor act of March 3, 1899, and provided for the formation and maintenance of an anchorage basin at Gulfport 1,320 by 2,640 feet in superficial dimensions, and a channel therefrom to the 19-foot contour in Mississippi Sound, a distance of about 7 miles. In the act of 1899 a depth of 19 feet at mean low water was specified for both the basin and the harbor channel, and a width of 300 feet for the latter, the estimated cost of this work being $748,109.96 for construction and $25,000 annually for maintenance. (See H. Doc. No. 120, 55th Cong., 3d sess.) The same act, however, authorized the Secretary of War to enter into a contract to dredge the channel and anchorage basin, at a cost not to exceed $150,000, and to contract for the maintenance of this channel and anchorage basin for the term of five years after its completion for the sum of $10,000 annually. Such a contract was entered into in 1901 and work was begun on April 26, 1901. Considerable difficulty was experienced by the contractor in dredging the channel and anchorage basin to the required dimensions, and finally, by joint resolution of Congress, approved June 14, 1906, authority was granted to accept the channel and basin as dredged and to pay the contractor $150,000 for the work. The maintenance period of five years was held to begin on the date of the above joint resolution. The river and harbor act approved March 2, 1907, authorized the Secretary of War to annul that portion of the contract relating to the maintenance of the channel and anchorage basin, and this was effected by supplemental agreement approved by the Secretary of War June 11, 1907. This project was modified by the river and harbor act of June 25, 1910, which authorized a depth of not to exceed 23 feet in the basin and the channel.

13. EAST PEARL RIVER, MISS.

The original project, adopted by the river and harbor act of July 5, 1884, provided for a channel 12 feet deep at mean low water. The estimated cost of the formation of this channel, no width being

Digitized by Google

mentioned, was $20,000. (Annual Report for 1885, p. 1367.) Under this project $5,000 was appropriated in 1888 and also in 1890, and bids were received, but were rejected as too high, no work whatever being done. Under the provisions of the river and harbor act of June 3, 1896, a survey was made with a view to obtaining a channel 17 feet deep at mean low water, and the report thereon is printed in Annual Report of the Chief of Engineers for 1897, page 1727, and in House Document No. 206, Fifty-fourth Congress, second session. A channel 300 feet wide and 9 feet deep at mean low water was all that could then be recommended, the estimated cost being $18,199.80. This project was adopted by the river and harbor act of March 3, 1899, and an appropriation of $18,199.80 made for the work. With these funds and the two former appropriations of $5,000 each a channel of the projected dimensions was finally dredged, at a cost of $27,853.92, the work being completed February 5, 1900. The balance of $345.88 was turned back into the Treasury.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE NEW ORLEANS (LA.) DISTRICT.

---

1 AND 2. SOUTH PASS AND SOUTHWEST PASS, MISSISSIPPI RIVER.

The first appropriation of $75,000 for improvement of the entrances to the Mississippi River was made by river and harbor act of July 4, 1836, and provided for closing some of the passages out of it by cutting ship channel, or by any other means which would be deemed expedient after the necessary survey was made. The next appropriation, $210,000, for improvement of entrances to the river, was made by river and harbor act of March 3, 1837, and upon recommendation of a board of engineers attempts were made to open Southwest Pass by using the ordinary bucket drag. No permanent improvement was effected, however, as a single storm sufficed to obliterate all the work which had been done.

Nothing further was done until an appropriation of $75,000 was made by the river and harbor act of August 30, 1852, for opening a ship channel of sufficient capacity to accommodate the wants of commerce, the work to be done by contract. A mixed board of one Naval and three Army Engineer officers was convened to decide how the appropriation should be applied. This board reported that under the limited 1852 appropriation no other plan than that of stirring up the bottom seemed adequate for obtaining any important results. In accordance with this report a contract was entered into with the Towboat Association, by which a channel through the bar of Southwest Pass 18 feet deep and 300 feet wide was made. The harrowing and dragging process, employed by the Towboat Association, proved successful, and a channel 18 feet deep was maintained for a whole year.

The report of the 1852 board is published in Executive Document No. 16, Thirty-third Congress, first session. This board reported that there were several methods by which the ship channel might be

Digitized by Google

improved, and stated them in the order of their simplicity, ease of work, and initial cost, as follows:

First. Stirring up the material of the channel bed by various means so that the river currents might carry away such material while in suspension.

Second. Assisting the stirring method by dredging and by carrying the dredged materials away by barges, etc., for special deposit outside of the channel.

Third. By narrowing, revetting, and jettying the mouths of the passes selected for ship channels and then closing the other passes.

Fourth. In case the above methods prove unsuccessful, then by connecting the deep-river channel at some suitable point between New Orleans and the passes by a ship canal to deep water in the adjoining Gulf.

The board recommended that these methods be tried in the order above given and that such work, being of experimental nature, should be done by Government forces rather than by contract. The first and second methods were considered doubtful as to permanent results but worth trying. In their discussion of the third method, that of jettying the pass selected for ship channels and closing minor passes, the board stated that "the project of jetties is based upon the simple fact that by confining the waters, which now escape uselessly in lateral directions, to a narrow channel, the depth in this narrow channel must be increased; in other words, the existing bar must be cut away." The fourth method, by the construction of a ship canal, was not recommended for trial until after the failure of the prior methods (the evident reason being that it would be more expensive and not as desirable as an open channel).

The 18-foot channel secured by the 1852 appropriation having disappeared, the sum of $330,000 was appropriated by the river and harbor act of July 8, 1856, for opening and keeping open a ship channel of sufficient capacity to accommodate the wants of commerce through Southwest Pass and Pass a Loutre, and required that such work should be done by contract. A board of engineers recommended that the bid of the Towboat Association be accepted for keeping open Southwest Pass by stirring up the bottom and that the method of keeping open the pass by jetties and closure of lateral passes be applied to both passes, and a contract was accordingly made to do this work. Work under the contract was begun at Southwest Pass by building a jetty about a mile long on the west side of the proposed channel. The appropriation being small in proportion to the work required for good results, the jetty was necessarily of light construction and consisted of a single row of pile planks strengthened at intervals by round piles. The structure was entirely too frail, and, after it had been seriously damaged by storm, the plan was abandoned, and the contractors were permitted to resort to the stirring-up process, which resulted in securing and maintaining, as long as that process was continued, an 18-foot channel. Further appropriations for work under the jetty method were prevented for several years by the advent of the Civil War.

By river and harbor act of March 2, 1867, an appropriation of $200,000 was made, and the construction of two dredges was authorized for this improvement. Under this authority the Government built a powerful dredge boat of special design, with a powerful cutter

Digitized by Google

and deflector, which was operated under the very best of conditions, but since it simply functioned by stirring up the material and deflecting it into the current, it did not succeed in maintaining a much deeper channel than that formerly secured by the simpler and less costly machines.

An act approved March 3, 1873, appropriated $34,988.53 to pay for work done by Horace Taylor, or by his authority, on the bar at the mouth of the Mississippi River, and for all claims under and by virtue of a contract entered into between him and Bvt. Lieut. Col. M. D. McAlester, of the date of November 5, 1866.

The necessities of commerce made it imperative that a better channel connection with the Mississippi River be obtained at an early date, and under a resolution of the House of Representatives of March 14, 1871, the Secretary of War was requested to cause an examination and survey, with plans and estimate of cost, to be made by an officer of the engineers for a ship canal to connect the Mississippi River with the Gulf of Mexico, or the navigable waters thereof, suitable location and dimensions for military, naval, and commercial purposes, and that he report upon the feasibility of the same to the House of Representatives.

The survey and estimates for canal, near Fort St. Philip, were submitted by a board of engineer officers, who reported that the construction of the canal with a depth of 27 feet and bottom width of 200 feet, having at the river end a lock with chamber 500 feet long, 60 feet wide, and depth over sill of 25 feet, was feasible and desirable, and was estimated to cost $10,273,000. A minority of the board (Gen. Barnard) reported that the experience gained with the jetties was sufficient to warrant still better results, and that the advantages of an open river were sufficient to warrant further experiments in this method at Southwest Pass, and he reasoned that the success of the jetty system, as applied to the mouth of the Danube, presaged even greater success if applied at South Pass.

The report of the board upon the canal project and the jetty method was followed by a proposition of Mr. James B. Eads, in February, 1874, to improve the entrance to the Mississippi River by jetties at Southwest Pass, for the sum of $10,000,000, payment to begin after a depth of 20 feet was secured and continuing as certain greater depths were secured until 28 feet had been secured and $5,000,000 had been paid, the remaining $5,000,000 to be paid in installments of $500,000 each, conditional upon the permanence of the channel for 10 years.

A controversy resulted as a consequence of this proposition between the advocates of the canal on one side and the supporters of the jetty system on the other side, and since a part of the discussion was theoretical, it was impossible to decide which was the better until further investigation of the jetty method could be had. Accordingly, on June 23, 1874, an act was passed, constituting a commission to investigate and report upon the improvement of the mouth of the Mississippi River. The report of this board was submitted January 13, 1875. (Report printed in Annual Report, 1875, p. 948.)

The board investigated the question of a canal below New Orleans, and estimated the cost of construction at $10,296,500 and $60,885 per annum for maintenance.

Digitized by Google

This board also considered the question of jetties, taking into consideration South Pass, Pass a Loutre, and Southwest Pass, and recommended construction of jetties at South Pass, at an estimated cost of $5,342,110 and annual cost of extensions, etc., $130,000; for Southwest Pass, estimated first cost for jetties $8,253,124 and annual cost for extensions, etc., $390,000.

The proposition of Mr. Eads, for the construction of the jetties at South Pass for $5,250,000, was accepted by the United States in 1875, and was along the lines of the recommendations made by this board. Work under his contract was commenced June 2, 1875, and completed in 1879. The maintenance period ended January 28, 1901. The total cost of the work, with maintenance, was $8,000,000.

The act of February 17, 1898, allotted $10,000 from the appropriation of $250,000 made by the river and harbor act of February 26, 1897, for the closing of a crevasse in Pass a Loutre, for the purpose of making a survey to determine the practicability of securing a navigable channel of adequate width and 35 feet in depth at mean low water of the Gulf of Mexico, through the Southwest Pass of the Mississippi River. The board was composed of three Engineer officers, and their report was printed in House Document No. 142, Fifty-fifth Congress, third session.

The board proposed the construction of parallel jetties in prolongation of the channel beyond the crest of the bar, and in addition to these certain auxiliary works were provided, including the construction of two dredges, all at a total estimated cost of $13,000,000.

4(a). LAKE PONTCHARTRAIN, LA.

The river and harbor act of August 30, 1852, appropriated $25,000 for harbor of refuge near Milneburg, in Lake Pontchartrain. Work was begun in 1853, and was finished in March, 1855. The breakwater consisted of four lines of piling, each about 1,500 feet long, and was located in front of the Pontchartrain Railroad wharf, about on the 12-foot contour. Piles were spaced 8 feet apart and were topped with square timbers.

While the top of the breakwater was in place it acted as a good protection, but by the fall of 1856, or during the winter of 1856 and 1857, the top was washed off and from that time it became a bad obstruction. In foggy weather schooners at times ran into it and incurred damages, and one schooner ran through it and was wrecked.

At the time the examination was made (report printed in H. Doc. 881, 60th Cong., 1st sess.) there remained about 1,000 piles in all, in four rows, constituting a dangerous obstruction to navigation.

9. BAYOU LAFOURCHE, LA.

The original project for this improvement was adopted in 1879, and is based on a survey authorized by the river and harbor act of March 3, 1873. Report of this survey is published in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1874, page 765, and provides for the improvement of the bayou by the removal of obstructions, snags, wrecks, and overhanging trees, etc.

Digitized by Google

The first appropriation was made by the river and harbor act of June 13, 1878, amounting to $10,000, and subsequent appropriations were made by the river and harbor acts of March 3, 1879, $10,000; June 14, 1880, $5,000; and July 5, 1884, $5,000; a total of $30,000.

Work on this improvement was suspended December 31, 1881, on account of high water, and resumed in September, 1882. From this time until January, 1883, the work was carried on steadily to a point 30 miles below Lockport, when the funds being nearly exhausted and the water becoming too high the plant was taken to Lockport and laid up.

The river and harbor act of August 22, 1882, directed that a survey be made. This survey was made in 1883, and report of same was published in Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1884, page 1291.

No work was done during the year ending June 30, 1884, the balance of available funds being too small.

In 1884, an amended project was submitted, and work was resumed in September, 1884, and continued until January, 1885, when it was again stopped on account of high water. No further work was done under this project. The total expenditures under this project was $29,920.39.

10. BAYOU TERREBONNE, LA.

The first work of improvement on Bayou Terrebonne was performed in accordance with the report dated February 27, 1880, published in House Executive Document No. 54, Forty-sixth Congress, second session. The improvement provides for a channel 4 feet deep at low water below Houma, by dredging and the clearing of the banks of overhanging trees, at an estimated cost of $18,800, afterwards increased to $38,800.

Under this project the work of dredging was carried on from 1880 to 1887, and channel 4 feet deep at low water secured for 23½ miles below Houma. A dredge boat was also constructed and partly paid for from the appropriations for this work. The expenditures under this project amounted to $38,641.10, which included a portion of the expense of the construction and repair of the dredge boat, and $158.90 reverted to the Treasury.

Due to a severe storm in 1909, Bayou Terrebonne and adjacent waterways became much obstructed by trees, marsh grass, etc., and under the provisions of the emergency appropriation act of March 3, 1905, allotments aggregating $10,000 were made by the Secretary of war for the restoration of usual channel depths and removal of obstructions. In Bayou Terbonne, 4,550 feet of channel was dredged; in Bush Canal, 5,222 feet; and in Bayou Little Caillou, 4,400 feet was dredged. Bayou Terrebonne was also cleared of obstructions for a distance of 6,260 feet. The cost of this work was $8,422.73. The balance amounting to $1,577.27 reverted to the Treasury.

There was expended on all projects prior to the present project the sum of $47,463.83.

12. BAYOU TECHE, LA.

The river and harbor act of March 2, 1829, provided for making a survey and estimate of cost of the entrance of Bayou Teche, with a view to improvement and shortening navigation of same. The

Digitized by Google

survey was made, and it was estimated that the cost of necessary improvement would amount to $30,000.

On May 5, 1870, a resolution was approved providing for survey and estimate of the cost of removing obstructions from the Bayou Teche, La. The survey was made (Annual Report for 1870, p. 347), and the river and harbor act of July 11, 1870, appropriated $17,500 for this work. The work was carried on by hired labor removing snags, overhanging trees, and other obstructions between the mouth of the stream and St. Martinville, La., a distance of about 75½ miles.

An examination of this bayou was authorized by the river and harbor act of March 3, 1879; a report with plans and estimates was published. (H. Ex. Doc. No. 54, 46th Cong., 2d sess., and Annual Report for 1880, p. 1167.) The improvement recommended in this report, provided for slack-water navigation as far up as Leonville, about 113½ miles from mouth of the bayou; three timber locks, with needle dams, were recommended besides removal of snags, etc., at an estimated cost of $58,190. The river and harbor act of June 4, 1880, appropriated $6,000 for commencement of this work. This was expended in removal of snags, overhanging trees, etc., between St. Martinville and Leonville, work being completed June, 1881. River and harbor act of March 3, 1881, made an appropriation of $20,000, and limited the improvement from St. Martinville to Port Barre, La.; in submitting subproject for its expenditure, it was recommended that a detailed survey, before precise plans were attempted, be made. This recommendation was approved and survey completed in 1883, extending from the head to Charenton, a point about 30 miles above the mouth. The data obtained recommended two locks having a lift of about 8 feet each, with a view to carrying low-water navigation to within 4 miles of Port Barre, at the head of the Teche, and that at ordinary high water this distance is also navigable. The estimate for this plan, which included removal of snags and obstructions was $135,625. One lock was located 5 miles below St. Martinville and the other below Bayou Fusilier. There being insufficient funds on hand for the completion of one of the locks, it was decided in 1884 that the slack-water improvement should not be started for the time being. River and harbor act of June 5, 1884, made appropriation of $6,000 for "continuing improvement." It was recommended that this appropriation, or as much of it as needed, be applied to removal of obstructions from the mouth to the head of the stream. This work was carried on, and in February, 1886, it was reported that there existed a channel sufficient to permit vessels 40 feet wide, drawing 5 feet to ascend to a point 3 miles below Arnaudville, La., and even 2 miles farther, excepting for the obstruction of the bayou by a fixed bridge.

A careful survey and study of the available water supply was made in 1886 which resulted in the plans and estimates being modified. The plan proposed contemplated the construction of one lock and movable dam at an estimated cost of $175,000 and $12,750 per annum for operation and maintenance, with a view to carrying slack water up to Arnaudville, about 31 miles above St. Martinville. This plan was not undertaken.

Digitized by Google

The river and harbor act of September 19, 1890, directed that another examination of the bayou from St. Martinville to Port Barre be made. This was done, and report recommended that the best means of meeting the requirements of commerce in the upper bayou was the construction of a submerged dam at St. Martinville of such a height that would back the water up to Leonville, at an estimated cost of $5,000. It was stated that in order to get sufficient data for a reliable estimate of cost, and to determine the effect of a dam, a detailed survey would be necessary. This plan was not undertaken.

Since 1891 the improvement of the bayou has been limited to that portion of the stream between the mouth and St. Martinville.

An examination of the bayou was directed by the river and harbor act of June 3, 1896. Report upon this examination was printed in House Document No. 69, Fifty-fifth Congress, first session. The plan of improvement recommended provided for securing a 6-foot navigation between St. Martinville and Port Barre by the construction of two locks in the Teche, one to be located below St. Martinville and the other below the mouth of Bayou Fusilier, and contemplates certain other construction and dredging. Estimated cost, $245,086.

No action was taken on this report, and the Committee on Rivers and Harbors requested the board of engineers to prepare and submit a supplemental report upon the above project, with a view to ascertaining whether the improvement of the channel can be obtained by the plans already considered and reported upon, or by other plans, and whether such channel would be feasible and desirable. This report was published in Rivers and Harbors Committee Document No. 39, Sixty-first Congress, second session. The board reported that the improvement of Bayou Teche above St. Martinville is not worthy of being undertaken by the General Government, but in stating this opinion the board realizes that the physical conditions of the stream as well as the needs of commerce may have materially changed since the survey of 1897, and recommended a resurvey.

Resurvey of the bayou was made and the report was published in House Document No. 527, Fifty-ninth Congress, first session, and is the basis of the present project, which was adopted by the act of March 2, 1907.

The amount expended under all previous projects prior to the adoption of the present project was $85,293.53 for improvement and $7,579.39 for maintenance, a total of $92,872.92.

19. CALCASIEU RIVER AND PASS, LA.

The first examination of Calcasieu Pass was made in 1871. Report of this examination was published in Annual Report of Chief of Engineers for 1871, page 557.

The original project based on this report was adopted by the river and harbor act approved June 10, 1872, and provides for dredging a channel 80 feet wide and 5 feet deep at mean low water through the bar in lake near head of Calcasieu Pass.

This project was modified May 12, 1881, based on report printed in House Executive Document No. 46, Forty-sixth Congress, third session, and provides for improvement of the river from Philips

Digitized by Google

Bluff to its mouth by removing logs, snags, and overhanging trees and by dredging, and for dredging bar at head of Calcasieu Pass, at an estimated cost of $25,080.

The river and harbor act of August 5, 1886, authorized the balance on hand appropriated for Calcasieu River to be expended on Calcasieu Pass, and based on report dated December 8, 1884, published in Annual Report of the Chief of Engineers for 1885, page 1410, provides for dredging a channel 100 by 6 feet through bar at head of Calcasieu Lake, and for channel 100 by 6 feet protected by plank revetment on each side at entrance to Calcasieu Pass. Due to the destruction of plank revetment by sea worms, the project was modified on January 8, 1888 (Annual Report for 1887, p. 1256), to omit the revetment.

In accordance with the project of 1872, a channel was dredged in 1873–74, redredged in 1882–83, and again in 1886, 1887, and 1888. For its protection there was built, in 1886 to 1888, 13,408 linear feet of plank revetment before this method of construction was abandoned.

In addition to this work, excavation of the channel through the bar at the mouth of the river was begun in 1887 and completed in 1888.

There was expended on the original project and its modifications prior to the adoption of the present project the sum of $46,488.05.

The act of August 5, 1886, ordered an examination of the bars at the mouth of the river and pass. Report of this improvement was published in Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1887, page 1402. This report was the basis of the project adopted by the river and harbor act of September 19, 1890, which, with the improvement of the river, covered by the modified original project, constitutes the present project.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENTS OF RIVERS AND HARBORS IN THE GALVESTON, TEX., DISTRICT.

---

1. GALVESTON HARBOR, TEX.

With appropriations made July 11, 1870; March 3, 1871; and June 10, 1872, a small dredge boat, two dump scows, and a steam tugboat were purchased for use on the inner Galveston Bar, and in 1873 the jetties constructed by the citizens of Galveston were repaired and strengthened. The river and harbor act of June 23, 1874, adopted the project, providing for the securing of a channel 18 feet deep by the construction of experimental jetties built of gabions filled with sand, at a total estimated cost of $1,759,401.85, appropriating $60,000 for beginning the work. (Ex. Doc. No. 136, 43d Cong., 1st sess.) The storm of September 15, 1875, destroyed a considerable portion of the work then in place. To June 30, 1880, a total of $618,431.75 had been expended. The project was then modified in 1880 to provide

Digitized by Google

for the construction of a jetty gulfward from Bolivar Peninsula, on north side of pass, to be built of brush mattresses and stone, with a view of securing depth of at least 25 feet over outer bar, at an estimated cost of $1,825,813. (Annual Report for 1880, p. 1221.) In 1883 the available funds becoming exhausted, the city of Galveston contributed $100,000 for the purpose of carrying on the work.

The project was again modified under river and harbor act approved August 5, 1886, and enlarged to provide for the construction of the north and south jetties 5 feet above low-water level and extend same to 30-foot contour in the Gulf, and to do such dredging as may be necessary from time to time to obtain a certain depth of 25 feet and a possible depth of 30 feet over both bars, at an estimated cost of $7,000,000. (H. Ex. Doc. No. 85, 49th Cong., 1st sess.) At this time there was a depth of about 20 feet over inner bar and 15 feet over outer bar. The U. S. seagoing dredge *Gen. C. B. Comstock* was built at a cost of $86,000 for work on this improvement and started work September 26, 1895.

The expenditures under this project amounted to $7,041,684.42 to September 8, 1900, and resulted in obtaining a depth of 26 feet at mean low tide on the outer and inner bars, an increase of 14 and 16 feet, respectively. The south jetty was 35,603 feet long and the north jetty 25,907 feet long, 7,000 feet apart at outer ends. The hurricane of September 8, 1900, damaged the jetties to a considerable extent and cost of repairs was estimated at $1,500,000. (Annual Report for 1901, p. 2018.) These repairs were begun under appropriation of June 13, 1902, and completed in 1906, a total of $1,200,000 being appropriated. To June 30, 1907, a total of $1,141,382.03 had been expended under this estimate, of which $261,003.91 was for maintenance of improvement. Total expended on all projects to June 30, 1907, was $8,519,684.42, of which $8,421,996.57 was for new work and $97,687.85 for maintenance.

2. GALVESTON CHANNEL, TEX.

The river and harbor act approved June 13, 1902, provided for the improvement of this channel from the outer end of the inner bar to Fifty-first Street to a depth of 30 feet at mean low tide and of such width in the respective portions as shall best subserve the interests of commerce, authorizing continuing contracts to the extent of $300,000. (H. Doc. No. 264, 56th Cong., 2d sess.) Under this project the channel was dredged to depth of 30 feet and width of 550 feet from outer end of inner bar to Thirty-first Street, and a width of 200 feet thence to Forty-fourth Street, and a pile and brush dike built parallel to and 1,400 feet distant from the face of the Galveston wharves, from a point opposite Tenth Street to Forty-first Street, a distance of 21,393 feet, with an extension built by the Southern Pacific Steamship Co., 3,757 feet long, in front of their wharves.

The river and harbor act approved March 3, 1905, provided for the purchase or construction of a hydraulic pipe-line dredge, at a cost not to exceed $125,000. This dredge, the *Col. A. M. Miller*, was purchased and accepted February 2, 1906, at a cost of $102,500.

The river and harbor act approved March 2, 1907, provided for the extension of the channel from Fifty-first Street to Fifty-sixth Street, at an estimated cost of $129,310. (H. Doc. No. 768, 59th Cong., 2d

Digitized by Google

sess.) A total of $549,675.12 was expended to June 30, 1907, of which $501,049.37 was for original work and $48,625.75 was for maintenance.

3. CHANNEL FROM GALVESTON HARBOR TO TEXAS CITY, TEX.

Early work of improvement was done by the Texas City Terminal Co., who in 1895–96 dredged a channel about 16 feet deep and 100 feet wide from deep water in Galveston Harbor to the shore, a distance of about 7 miles. This channel had shoaled to about original condition when work was undertaken by the United States, under the river and harbor act approved March 3, 1899, under a project adopted for dredging a channel 25 feet deep and 100 feet wide on the bottom, at an estimated cost of $250,000. This project was completed under contract to June 30, 1905, at cost of $250,000, the Texas City Co. paying the cost of superintendence, inspection, etc.

Under the river and harbor act approved June 25, 1910, the project was enlarged in accordance with report printed in House Document No. 328, Sixty-first Congress, second session, and provided for maintenance of the channel and deepening to 30 feet and widening to 200 feet on the bottom, and extending inner end 687 feet, to connect with new slip, at an estimated cost of $410,000. A total of $561,905.69 had been expended prior to adoption of present project, of which $366,822.48 was for original work and $195,083.21 was for maintenance, exclusive of $337,670.17 expended by the Texas City interests, of which $16,028.61 was for maintenance of improvement.

4. CHANNEL TO PORT BOLIVAR, TEX.

The river and harbor act approved March 2, 1907, appropriated $50,000 for work of improvement providing for a channel from deep water in Bolivar Roads 25 feet deep at mean low tide and 150 feet wide on bottom with increased width in front of wharf of Gulf & Interstate Railway, the total length being about 4,275 feet. This project was completed June 14, 1909, at a cost of $48,710.75, the width in front of wharf being 600 feet. (H. Doc. No. 719, 59th Cong., 1st sess.) A total of $94,811.50 had been expended, of which $48,710.75 was for new work and $46,100.75 for maintenance.

5. HOUSTON SHIP CHANNEL, TEX.

Survey of this waterway was made in 1871 with a view of securing a channel 6 feet deep and 100 feet wide. First work undertaken by the Government with its own plant under appropriation approved June 10, 1872, was a cut through Red Fish Bar 7½ feet deep and 70 feet wide and 1,500 feet long. With appropriation of June 23, 1874, this cut was extended a distance of 2,982 feet and 60 feet wide. A further appropriation on March 3, 1875, of $10,200 provided for the deepening of cut to 10 feet and widening to 150 feet. Under same date an appropriation of $25,000 was made to improve ship channel between mouth of San Jacinto River and Bolivar Channel to be considered an extension of the Red Fish Cut. The Red Fish Cut was deepened to 14½ feet for a distance of 6,100 feet connecting with 9 and 8½ feet depths in bay. Appropriation of $72,000 was made

Digitized by Google

available on April 25, 1877, but action was deferred pending decision of Congress as to route of channel as reported on by board of engineers under date of September 10, 1877, and printed in Annual Report of Chief of Engineers for 1877, pages 459–468. The act of Congress approved June 18, 1878, appropriated an additional $75,000 and provided that the amounts were to be expended between Red Fish Bar and Bolivar Channel. Under contract a channel was dredged 12 feet deep and 100 feet wide during 1879–80. An appropriation of $80,000 was made by act of Congress approved March, 1879, for improvement of channel between Red Fish Bar and Morgan Canal subject to certain conditions to be complied with by the Buffalo Bayou Ship Channel Co., a private corporation which had dredged a canal through Morgan Point and for a distance of about 4.8 miles into Galveston Bay, the question involving collection of tolls by this company.

Under title of "Improving Buffalo Bayou," work of snagging, cutting overhanging trees, and dredging of shoals between mouth of White Oak Bayou at foot of Main Street, Houston, and the mouth of Simms Bayou, about 10 miles below Houston, was begun under appropriation approved March 3, 1881, a total of $95,522.13 being expended to June 30, 1885.

The river and harbor act of July 5, 1884, provided that no further work be done in Galveston Bay until the Secretary of War shall be satisfied that the Buffalo Bayou Ship Channel Co. has relinquished or abandoned to the United States all the franchises and any and all right to collect or impose tolls or charges from any part of said ship channel or Buffalo Bayou. The river and harbor act of August 5, 1886, omitted the condition required of the Buffalo Bayou Ship Channel Co. and provided for continuation of the work on channel and suitably marking same. The channel having deteriorated to about its original condition, work was begun under contract to dredge channel 12 feet deep and 100 feet wide between Bolivar Channel and Red Fish Bar, which was completed July 20, 1889. A small amount of snagging and dredging of shoals was also done in the upper section of Buffalo Bayou from 1888 to 1892.

On May 4, 1892, the Morgan Canal and Cut was purchased by the United States from the Buffalo Bayou Ship Channel Co. for $92,316.85, the value being appraised by board of commissioners appointed under authority of the river and harbor act approved September 19, 1890. The route of the channel was then changed from connection with mouth of San Jacinto River over Cloppers Bar, to connect with canal and cut dredged through Morgan Point by private parties at its lower end, near Morgan Beacon, 4.8 miles from Morgan Point, and a channel was dredged under contract 9½ feet deep and 150 feet wide between Morgan Beacon and Red Fish Bar, with cut 12 feet deep and 75 feet wide along center of 150-foot channel. The banks of canal at Morgan Point were graded and a sheet-pile bulkhead revetment built 1,959 feet long. A small amount of dredging and snagging was done in upper section of the bayou under contract. Amount expended prior to existing project to June 30, 1898, ship channel in Galveston Bay (including purchase of Morgan Canal and Cut, $92,316.85), $800,328.16, and Buffalo Bayou, Tex., $210,137.64; a total of $1,010,465.80.

Digitized by Google

6. WEST GALVESTON BAY CHANNEL, TURTLE BAYOU, TRINITY RIVER, ANAHUAC CHANNEL, OYSTER CREEK, CEDAR, CHOCOLATE, AND BASTROP BAYOUS, TEX., INCLUDING MOUTHS OF ADJACENT STREAMS.

This project has embraced the improvement of the following localities: West Galveston Bay, the Galveston & Brazos Canal, Hanna Reef (East Bay Bayou), Double Bayou, Anahuac Channel, mouth of Trinity River, Turtle Bayou, Cedar Bayou, Clear Creek, Dickinson Bayou, Chocolate Bayou, Bastrop Bayou, Oyster Creek. (Annual Report for 1900, p. 2438.)

Prior to March 3, 1899, the improvement of West Galveston Bay and the Galveston & Brazos Canal, Double Bayou, mouth of Trinity River, and Cedar Bayou were independent. The river and harbor act of that date made an appropriation for the improvement of the Brazos River between Velasco and Richmond, West Galveston Bay Channel, Double Bayou, and the mouths of adjacent streams. The mouth of Trinity River and Cedar Bayou were transferred to this work, and Anahuac Channel was added by the act of March 3, 1905. Chocolate and Bastrop Bayous were added by the act of March 2, 1907, and Turtle Bayou and Oyster Creek by the act of June 25, 1910. As adjacent streams, Hanna Reef (East Bay Bayou), Clear Creek, and Dickinson Bayou have been improved. Double Bayou has not been specially named in the act since 1905 and is now under improvement as an adjacent stream. The Brazos River between Velasco and Richmond, which was included in the improvement for a time, is now covered by a separate appropriation.

The object of this improvement, in part, is to obtain and maintain a navigable channel depth of from 4 to 6 feet across the bars at the mouths of the streams and bayous from deep water in the bay to deep water in the bayous. The improvement is intended to develop a light-draft inland navigation which will afford cheap transportation by light-draft steamers and barges to the coast country of Texas. The estimated cost of the modified project has been given in previous reports as $248,646.34, but as works originally embraced in this project have been transferred to other appropriations and new works have been added for which no estimates of cost have been made, there is no estimated cost for the entire project. All the channels called for have been completed, but maintenance is regularly required. More and larger boats, especially power boats with schooner hulls, have been built to utilize the improvement. Most of these boats are owned by private parties and are not in regular commercial service, and no satisfactory records of tonnage can be obtained. Most of the points reached are settlements not on railroads, and the improvements are of great importance to their commercial life. The effect of these improvements has been generally to decrease freight rates to all points reached by the channels improved.

By authority of river and harbor act of March 3, 1899, a pipeline hydraulic dredge was constructed for the improvement of these streams at a cost of $67,992.51. This dredge, *General H. M. Robert*, was burned April 18, 1909, and the dredging was carried on by the dredge *Captain C. W. Howell.* The latter, however, was lost at sea September 14, 1911, and, there being no other Government plant

Digitized by Google

available for maintenance of the light-draft projects, the hydraulic dredge *No. 8* was purchased from the Bowers Southern Dredging Co., of Galveston, Tex., for $29,500 for use on this and the inland waterway work. This dredge was renamed the *San Bernard*, and has been engaged on maintenance of the light-draft projects since April 16, 1913. The amount expended prior to operations under existing project was $108,050.

(*d*) MOUTH OF TRINITY RIVER, TEX.

Project for improvement was adopted by river and harbor act approved June 18, 1878, and provided for the removal of snags from the river below Liberty, about 30 miles above the mouth, and in dredging a channel 6 feet deep at mean low tide and 80 feet wide across the bar at mouth of the pass then in use by vessels, at an estimated cost of $22,581.40. (Annual Report for 1873, p. 685.) This project was amended by river and harbor act approved May 4, 1884, and provided for the erection of two parallel jetties, or wooden revetments, at mouth known as Middle Pass, 275 feet apart and extending about 7,750 feet into upper Galveston Bay; also in closing the other two principal passes by submerged dams, to create and maintain a channel about 6 feet deep at mean low tide at the mouth of the river, at an estimated cost of $89,500. A total of $69,444.76 had been expended on the project to June 30, 1889.

7. INLAND WATERWAY ON THE COAST OF TEXAS.

(*a*) WEST GALVESTON BAY AND BRAZOS RIVER CANAL.

Previous to 1908 the improvement of these channels was carried on under appropriations for "channel in West Galveston Bay, Tex.," and "improvement of Brazos River between Velasco and Richmond, West Galveston Bay Channel, Double Bayou, and the mouths of adjacent streams." The project adopted by the river and harbor act of July 13, 1892, provided for widening, deepening and straightening the channel by dredging, so as to afford a least width of 200 feet and depth of 3½ feet between the railroad bridges and San Luis Pass in the bay, and a least width of 100 feet and depth of 3 feet along Christmas Point, and to suitably mark the channel with beacons, at a total estimated cost of $28,998.80. (H. Ex. Doc. No. 22, 52d Cong., 1st sess.) This project was modified by river and harbor act approved July 8, 1896, to provide for deepening the channel to 5 feet, provided the cost were not increased.

The Galveston & Brazos Canal had been dredged by private parties in 1851–53, from the Brazos River to Oyster Bay, a distance of about 10 miles. This canal was 100 feet wide and about 6 feet deep, and afforded an inland passage for light-draft boats between Galveston and the Brazos River. Under the river and harbor act approved June 13, 1902, this canal was purchased by the United States at a cost of $30,000, to form a link in the chain of inland waterways. (See H. Doc. No. 89, 54th Cong. 2d sess.)

Digitized by Google

9. MOUTH OF BRAZOS RIVER, TEX.

Work of improvement was begun under river and harbor act approved June 14, 1880, which provided for the construction of jetties to obtain a navigable channel across the bar at the mouth of the river, at an estimated cost of $246,484, which was revised in 1881 to $442,890.40. To 1889 the work consisted in construction of a north jetty of brush mattresses and stone 2,433 feet long and a foundation partly completed for shore end of south jetty, a total of $142,098.43 being expended. The work was then suspended.

Under the river and harbor act approved August 9, 1888, the Brazos River Channel & Dock Co., a private corporation chartered under the laws of the State of Texas February 16, 1888, was authorized to construct, own, and operate jetties and other auxiliary works for the purpose of creating a navigable channel at the mouth of the Brazos River. This company constructed two parallel jetties 560 feet apart, the northeast jetty 4,708 feet long and the southeast jetty 5,018 feet long. This work having failed to accomplish the desired results, and the company not being financially able to proceed with the work, the river and harbor act approved June 3, 1896, provided for the appointment of a board of engineers to report on the character and value of the improvements made by the company, appropriating $5,000 for the expense of this investigation and report. (S. Doc. No. 138, 54th Cong., 2d sess.)

The river and harbor act approved March 3, 1899, contained the following item:

> Mouth of Brazos River, Texas: For dredging and such other work as may be deemed most effective in the judgment of the Secretary of War in improving and developing the harbor, eighty-five thousand dollars: *Provided*, That no part of said sum shall be expended until the Brazos River Channel and Dock Company shall file with the Secretary of War a transfer to the United States of the jetties and auxiliary works, also a release of all rights and privileges conferred upon said company by its charter or by the act of Congress approved August ninth, eighteen hundred and eighty-eight, to charge or collect tolls for the use and navigation of said river; and the Secretary of War is directed to have an examination made of the mouth of the Brazos and the jetties, and report to Congress the estimated cost of extending the jetties one-half mile, and the estimated depth and width of the channel to be obained by such extension, and the estimated cost of obtaining twenty feet of water and a channel one hundred and fifty feet wide.

The Brazos River Channel & Dock Co. on April 25, 1899, released all rights and privileges previously conferred, and the United States resumed work of improvement on July 11, 1899, with a project to strengthen the jetties, construct spur dikes and bank protection, and to dredge a channel 18 feet deep and 150 feet wide, at an estimated cost of $250,000, which was increased by $175,000 after the hurricane of September 8, 1900. (H. Doc. 652, 56th Cong., 1st sess.) The project is completed.

10. BRAZOS RIVER, TEX., FROM VELASCO TO OLD WASHINGTON.

The work of improvement was begun under project adopted by river and harbor act approved June 3, 1896, which provided for the removal of snags and overhanging trees, and the dredging of the troublesome shoals between Velasco and Richmond only, with an appropriation of $5,000.

Digitized by Google

13. PORT ARANSAS, TEX.

Work of improvement was begun in 1869 by the citizens of Rockport and Corpus Christi, who raised by subscription about $10,000, which was expended under direction of a Mr. Halliday in building a light crib-work jetty about 600 feet long from the shore line of St. Joseph Island across a secondary channel. Apparently as a result of this work the secondary channel shoaled about 2 feet and the main channel was deepened 2 feet. Wave action and the teredo soon destroyed this structure.

Improvement by the United States began under river and harbor act of March 3, 1879, which appropriated $35,000 to be expended under plan printed in Annual Report of the Chief of Engineers, 1879, page 928, et seq., which provided for obtaining a channel 12 feet deep across the bar, and, if funds permitted, the protection of head of Mustang Island from erosion. The report of board of engineers, printed in Annual Report of the Chief of Engineers, 1880, page 1260, contemplated the construction of two parallel jetties about 3,000 feet apart extending into the Gulf of Mexico from the south end of St. Joseph Island and the north end of Mustang Island; the protection of the north end of Mustang Island from erosion by construction of groins in conjunction with a beach flooring of mattresses and the planting of trees on St. Joseph Island for its protection against abrasion by winds, at an estimated cost of $759,185. Under this project the head of Mustang Island was protected by groins and mattresses; sand fences were built on St. Joseph and Mustang Islands, and the partial construction of south jetty from head of Mustang Island for a distance of 5,500 feet. No north jetty was built. Work suspended in April, 1885. A storm in September, 1885, damaged the work seriously.

The project was modified July 25, 1887, by the Chief of Engineers as recommended by the Board of Engineers in their report of July 19, 1887, and printed in Annual Report of the Chief of Engineers, 1888, page 1312, et seq., so as to provide for the construction of two parallel jetties 2,000 feet apart out to the 20-foot curve, the jetties to be constructed of stone 12 feet wide on top at inner end and increasing to 24 feet wide at outer end, with a crest of 5 feet above mean low tide, and the protection of the north end of Mustang Island with riprap 18 inches thick extending from high water to the bottom, or nearly to bottom of channel, all at an estimated cost of $1,688,500. The Chief of Engineers directed that the existing funds be used in the protection of head of Mustang Island, which was completed. No work was done on the jetties for want of funds, and in 1890 the project was undertaken by the Aransas Pass Harbor Co.

The Aransas Pass Harbor Co., a private corporation, chartered under the laws of the State of Texas, was granted certain rights and privileges under a special act approved May 12, 1890, and they constructed sections of jetties on each side of the pass, that section on the north side being a curved reaction jetty, detached from the shore. As their plans failed to secure the desired results they relinquished their rights on March 27, 1899, as provided for under the river and harbor act approved March 3, 1899, the United States taking over the further work of improvement and completing the north jetty

Digitized by Google

under the plans and specifications of the Aransas Pass Harbor Co. as provided for by the river and harbor act approved June 13, 1902, and the river and harbor act approved March 3, 1905, at a cost to the United States of $546,703.10.

The river and harbor act approved March 2, 1907, provided for the construction of a south jetty parallel to the general direction of the existing north jetty, and the extension shoreward of the north jetty to connect with St. Joseph Island, and later the extension of both jetties, to obtain a depth of 20 feet, in accordance with plans submitted by the Board of Engineers for Rivers and Harbors, published in Rivers and Harbors Committee Document No. 5, Fifty-ninth Congress, second session, at an estimated cost of $1,288,699.50, including $100,000 for a dredge. Under the river and harbor act of June 25, 1910, in accordance with report submitted in House Document No. 639, Sixty-first Congress, second session, the project was extended to cover the repairing of the north jetty, dredging and removal of obstructions in the channel, and was diminished by omitting the seaward extension of 1,750 feet of the jetties, the revised estimate being $1,157,500.

The river and harbor act approved February 27, 1911, adopted the project printed in House Document No. 1904, Sixty-first Congress, third session, which provides for a deep-water harbor to be established between Harbor Island and St. Joseph Island, the harbor to be 20 feet deep, with a width of 1,200 feet, for a distance of 3,000 feet from the upper end of the pass, and to extend thence with the same depth 400 feet wide from the north end for a distance of 5,420 feet, together with a protective stone dike 10,000 feet long, to be built on St. Joseph Island, connecting with the north jetty, all at an estimated cost of $375,000, with $25,000 annually for maintenance after completion. This act also provided that no part of the appropriation and authorization should be expended until the Secretary of War is satisfied that the interests of the general public will be duly protected in the use of the harbor and that no terminal monopoly will be possible, and that the title and easements in any land needed in the construction of the dike proposed as a part of the improvement shall have been invested in the United States free of cost. These conditions have been met. The dike on St. Joseph Island was constructed and deep-water harbor dredged to depth of 20 feet at mean low tide, with the extension from north end 150 to 400 feet wide for a distance of 2,000 feet, there not being sufficient funds to complete to full width and length. Dredging between jetties was done with Government plant.

14. CHANNEL FROM ARANSAS PASS TO CORPUS CHRISTI, TEX.

The river and harbor act of March 2, 1907, provided for the improvement of this locality under the title of "Turtle Cove Channel between Aransas Pass and Corpus Christi, Tex.," appropriating a total of $123,750 with which to dredge a channel 8½ feet deep at mean low tide, and 75 feet wide on the bottom, between Aransas Pass and Corpus Christi Bay. This channel was completed in 1909 and partly redredged in 1910, at a total cost of $126,723.57, of which $122,552.14 was for original work and $4,171.43 was for maintenance.

Digitized by Google

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE DALLAS, TEX., DISTRICT.

2. MOUTHS OF SABINE AND NECHES RIVERS, TEX.

Under a project for the Sabine River, La. and Tex., adopted by the river and harbor act of June 18, 1878, based on reports of surveys dated April 28, 1871, and July 28, 1873 (Annual Report for 1871, p. 540, and for 1873, p. 681), which in part provided for the dredging of a channel through the bar for the use of 5-foot boats at an estimated cost of $13,000.33, a channel was dredged in 1879 and 1880 6 feet deep at mean low water and 70 to 100 feet wide. This channel was redredged in 1883 and 1896, the latter work being done under a diversion of $4,000 from the appropriation for Sabine Pass authorized by the sundry civil act of March 4, 1895. The total amount spent on the improvement was approximately $24,000.

Under a project for the improvement of the Neches River, Tex., adopted by the river and harbor act of June 18, 1878 (based on a report of survey dated November 22, 1873—Annual Report for 1874, p. 474—in which a channel across the bar 5 feet deep and 80 feet wide, at an estimated cost of $26,318.05, was recommended), a channel was dredged in 1880, 5 feet deep at mean low water, 30 to 60 feet wide. This channel was redredged in 1889 and again in 1896, a channel 50 feet wide and 6 feet deep being secured in the latter year. The total amount expended was approximately $24,750.

The river and harbor act of March 3, 1889, appropriated $10,000 for "improving the mouths of Sabine and Neches Rivers," and for the expenses of making a reexamination by a board of engineers of the proposed channel through Sabine Lake. This appropriation was apparently based on the survey of February 11, 1897 (report printed in H. Doc. No. 299, 54th Cong., 2d sess., in which an 8-foot channel 150 feet wide from the 8-foot contour in Sabine Pass to deep water in the Sabine and Neches Rivers was recommended). The sum of $113.01 was spent for the reexamination of the project by the board, and $9,812.28 in dredging a 60-foot channel 8 feet deep from the 7-foot contour of the Neches River to the 6-foot contour of Sabine Lake, and a 60-foot channel 7 feet deep from the 6-foot contour of the Sabine River to the 6-foot contour of Sabine Lake.

4. HARBOR AT SABINE PASS AND PORT ARTHUR CANAL, TEX.

The first project for work at this harbor was based on a report by the district officer dated February 4, 1875 (Annual Report, for 1875, p. 1945), submitted under instructions from the Chief of Engineers. It was inferentially adopted by the act of March 3, 1875. It provided for dredging a channel across the bar 12 feet deep, 150 feet wide, 2½ miles long, at an estimated cost of $105,026. Dredging by contract was carried on during the fiscal years 1876 and 1877, and by the U. S. dredge *Essayons* (apparently with the intention of obtaining 20 feet depth) during the fiscal years 1878, 1879, and 1881. In addition to the dredging on the bar, a 15-foot channel across the reef that separated the harbor of Sabine City from the roadstead inside the outer bar, was dredged. The desired channel depth across

Digitized by Google

the bar, though secured at different times, was not maintained. The total expenditures under this project were $161,703.94. The remaining balance of $151,296.06 was applied to the next project.

The second project was based on a report of the district officer dated January 28, 1882 (published as H. Doc. No. 147, 47th Cong., 1st sess). This project called for two brush-and-stone jetties, 1,800 feet apart, to extend across the bar to 18 feet depth of water, to be built to mean low water, the west jetty to be 18,120 feet long and the east jetty 19,800 feet long; also, if necessary, dredging a channel 20 feet by 100 feet, at a total estimated cost of $3,177,606.50, of which $160,000 was for dredging. The project was inferentially adopted by the act of August 2, 1882. Work on this project was commenced in January, 1883, the west jetty being started first. The east jetty was started in March, 1885. In 1891, it was decided to raise portions of the jetties to 2 feet above mean high water and to abandon the use of alternate layers of brush and small stone above the brush foundation. Dredging was started in 1893 and carried on until 1896. At the close of the fiscal year 1896 the east jetty had been built to a total length of 19,500 feet, of which 17,100 feet had been completed and 2,400 feet was under construction; the west jetty was 14,875 feet long, of which 6,609 feet was raised to 2 feet above mean high water, 7,966 feet to mean low water, the remaining 300 feet being foundation work. The channel had a depth of 24 feet and an average width of 100 feet, the total amount of material removed by dredging having been 1,276,631.74 cubic yards. The total expenditures had been $1,834,838.08.

By the act of June 30, 1896, this project was modified to the extent of authorizing a continuing contract of $1,050,000, which, added to the amounts already made available, apparently limited the total cost of the project to $2,996,046.06, but in addition to this $130,000 was appropriated for the construction and operation of a dredge boat in the act of June 4, 1897, and $150,000 by the act of March 3, 1899, for improving the main ship channel inside the harbor between a point 1,000 feet north of the United States life-saving station and a point opposite the lighthouse. The project approved by the Secretary of War December 8, 1896, under the continuing contract authorization of that year, provided for constructing 5,300 linear feet, more or less, of the east jetty, and 6,600 linear feet, more or less, of the west jetty, and for deepening the channel by dredging. A contract for this work was approved June 22, 1897, work was commenced August 10, 1897, and the jetty work under this contract completed on August 6, 1900. The condition of the jetties at this time was as follows: The east jetty had been extended to a length of 25,100 feet, of which 21,540 feet was capped, 960 feet was riprap, and 2,600 feet was foundation only; and the west jetty to 22,000 feet, of which 15,250 feet was capped, 1,800 feet was riprap, and 4,950 feet was foundation only. Dredging in the channel under contract was carried on in the fiscal years 1898 and 1899, approximately 700,000 cubic yards being removed. Dredging in the channel was also carried on under contract from November 28, 1900, to January 3, 1901, with an allotment of $8,000 from the emergency appropriation of June 6, 1900, 61,538 cubic yards being removed. The dredge *Sabine*, built under the authorization for the construction of a dredge, was completed in January, 1901, and dredged from February 9 to June 30, 1901, from

Digitized by Google

October 28, 1901, to January 15, 1902, and from February 17, 1902, to June 30, 1902, removing, approximately, 470,000 cubic yards of material. The work during the last two periods was carried on under an allotment of $2,000 from the emergency appropriation of June 6, 1900, and with funds contributed by the Kansas City Southern Railway, respectively. The work of dredging in the inner harbor under the appropriation of March 3, 1899, was begun in 1899, and up to June 30, 1902, 822,836 cubic yards had been removed, the work being six-tenths completed. The available depth between the jetties was 22 feet. The total amount expended under this revision of the project to June 30, 1902, was $1,358,357.18. Of the appropriation of $130,000 of 1897, $16,297.03 reverted to the Treasury.

In the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1901, page 1911, it was reported that there had been an unusual and unexpected amount of settlement of the jetties, and that additional work was desirable beyond that contemplated by the project of 1896 to secure the full benefits of the improvement. A revised estimate for completing the jetties "to their originally projected length and height" was given, amounting to $1,116,573. This report also contained (p. 1919) a special report on the damage to the jetties by the hurricane of September, 1900 (also printed in H. Doc. No. 152, 56th Cong., 2d sess.). The cost of repairing this damage was given as $100,000. This amount, however, was also included in the $1,116,573 above referred to. This report also contained (on p. 1915) a report on preliminary examination and survey for widening and deepening to 24 feet the channel from a point about 1,000 feet north of the life-saving station to the entrance to the Port Arthur Canal at a cost of $25,000 (printed in H. Doc. No. 70, 56th Cong., 2d sess.). The act of June 13, 1902, specifically adopted this latter project, and by inference in connection with subsequent appropriations adopted the project for completing the jetties at a cost of $1,116,573. The work on the inner channel to a point 1,000 feet above the life-saving station, begun in 1899, was completed in April, 1903, and the work of dredging the channel from that point to the entrance of the Port Arthur Canal was completed February 27, 1903. The dredge *Sabine* worked yearly in the jetty channel, removing up to June 30, 1912, 3,812,351 cubic yards under this project. Jetty work was carried on whenever funds were available. On the east jetty 214,791.37 tons of stone were placed, and in addition 1,455 granite capping blocks, which were taken from the west jetty; on the west jetty 50,873.73 tons of riprap and 7,094.72 tons of coping stone were placed; also 10,871.69 cubic yards of concrete placed as coping. The condition of the jetties on July 1, 1912, was substantially as follows: The east jetty was completed to 4 feet above mean low gulf level for about 14,300 feet, built up to about mean low gulf level for about 8,100 feet, and mattress foundation placed, but partly destroyed, for about 3,000 feet. The west jetty was completed to 4 feet above mean low gulf level for about 15,800 feet, built to about mean low gulf level for about 1,200 feet, and mattress foundation placed, but partly destroyed, for about 4,000 feet. The approximate amount expended was $1,192,948.99, of which approximately $830,000 was applied to the jetties. The amounts expended for new work and for maintenance can not be accurately separated. It was estimated that $708,434.01 had been expended in maintenance of all

Digitized by Google

jetty projects. There was an available depth of 25 feet through the channel.

The Port Arthur Ship Canal was dug to 25 feet depth during the years 1897 and 1899 by the Port Arthur Channel & Dock Co., a subsidiary of the Kansas City Southern Railway Co. This railroad, which was then building, desired to construct docks farther inland than Sabine Pass, and accordingly selected a site near where Taylors Bayou empties into Sabine Lake. A slip, a lumber basin, and a turning basin were excavated at this point. In 1902 it became necessary to redredge the canal for nearly its entire length, and this work was completed in March, 1903. The channel and dock company then built a dredge, which was operated in maintaining the canal for over three years. Under the provisions of an act of Congress approved June 29, 1906, the Port Arthur Ship Canal, lumber, and turning basins, together with a strip of land along the canal, were conveyed to the United States free of cost. The deed of conveyance from the Port Arthur Channel & Dock Co. was accepted by the Secretary of War on December 13, 1906, from which date the canal became a public waterway of the United States. Cession of jurisdiction over the property was executed by the governor of the State of Texas on February 27, 1907. A survey of the canal was completed May 10, 1907. The following table gives a summary of the condition of the canal at the time of its acceptance by the United States:

	Length.	Average top width.	Width between 20-foot contours.	Maximum depth.	Minimum depth.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Canal	37,600	200	80	25.1	22.0
Turning basin	1,800	625	530	27.1	23.7
Lumber basin	1,200	160	100	26.2	23.1

The dredge *Port Arthur*, previously in use by the company, was purchased, and operations for the maintenance of the canal and basins were carried on under the permanent indefinite appropriation for operating and care of canals and other works of navigation to the time of the adoption of the project of July 25, 1912, which combined the improvement of the Port Arthur Canal with the improvement of the harbor at Sabine Pass. The dredge *Port Arthur* having become worn out, was dismantled, and a new hydraulic pipe-line dredge (the *Orange*) was constructed, at a cost of $84,520, and delivered in May, 1912. The total amount expended on the maintenance of the Port Arthur Canal to June 30, 1912, was $267,112.63.

10. RED RIVER, BETWEEN FULTON, ARK., AND THE MOUTH OF THE WASHITA RIVER, OKLA.

The original project for the Red River above Fulton was adopted by the following provision of the river and harbor act of August 5, 1886:

Improving Red River, Ark., above Fulton, Ark., $7,000.

Digitized by Google

It was evidently based on the survey ordered by the river and harbor act of July 5, 1885, report of which was published in Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1885, page 1617. It provided for the improvement of navigation at medium and high stages to the mouth of the Kiamichi River, 158 miles above Fulton, by the removal of snags and drift. The estimated cost was $10,000. No estimate for maintenance was given. Work was begun in the fiscal year 1888 and carried on until 1891, when the project was reported as practically completed. The amount expended was $13,273.82, including $1,500 received from the sale of a snag boat. The work was not of a permanent character, and under subsequent appropriations work of maintenance was carried on until 1905, $20,226.18 having been expended, making a total of $33,500 for this project. All work had been done by hired labor and Government plant, the latter generally belonging to the improvement of Red River below Fulton.

By the following provision of the river and harbor act of March 3, 1905:

Improving Red River in the States of Louisiana, Arkansas, and Texas and Indian Territory: For continuing improvement and for maintenance, $200,000: *Provided*, That of this amount $100,000 may be expended between Fulton, Ark., and Denison, Tex.—

the project was extended to include that portion of the river from the mouth of the Kiamichi to Denison, 123 miles, making the total length under improvement 281 miles. No estimate of the cost of this improvement had been made. The project is stated in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1896, and in subsequent reports, as contemplating "the removal of drift and snags, clearing the banks of timber in danger of caving into the river, and closing chutes and cut-offs where necessary." Work under this modified project was carried on until 1912, a total of $315,029.20 having been expended. All work was carried on by hired labor, a steam snag boat, the *C. A. Culberson*, and a number of quarter boats having been constructed.

Under the following provision of the river and harbor act of June 25, 1910:

Improving Red River, La., Ark., Tex., and Okla.: Continuing improvement and for maintenance below Fulton, Ark., $75,000; continuing improvement and for maintenance between Fulton, Ark., and Denison, Tex., $50,000: *Provided*. That of this latter amount so much as shall be necessary may, in the discretion of the Secretary of War, be expended for removing snags and other obstructions in the lower 25 miles of the Kiamichi River, a tributary of Red River, in the State of Oklahoma—

and the general provision contained in the act of July 25, 1912, authorizing the Chief of Engineers after approval by the Secretary of War to remove snags from tributaries of waterways already under Federal improvement, the lower 25 miles of the Kiamichi River were snagged in the fiscal years 1912 and 1913 at a total cost of $3,854.07, which is included in the figures above given for the Red River.

11. SULPHUR RIVER, TEX. AND ARK.

The first project for the improvement of Sulphur River was adopted by the river and harbor act of August 18, 1894, which author-

Digitized by Google

ized the use of $5,000 from the appropriation for improving Red River, "for improving the Sulphur River, a tributary of the Red River." This project was evidently based on a report on the preliminary examination ordered by the river and harbor act of July 13, 1892, in which it was recommended that the lower portion of the river up to Sulphur Station (31 miles from the mouth) be cleared of snags and other obstructions. No estimate of cost was given. In 1896 and 1897, $2,488.99 of this appropriation was spent in snagging the river to the Kansas City Southern Railway bridge, mile 26. At the conclusion of this work the river was reported as having been put "in fair navigable condition at ordinary stages." The balance of the appropriation reverted to the funds for the general improvement of Red River under the authority contained in the act of June 13, 1902.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE VICKSBURG, MISS., DISTRICT.

RED RIVER, LA. AND ARK., BELOW FULTON, ARK.

The original project for this improvement was adopted by act of Congress approved May 23, 1828, and between that date and 1841 more than $425,000 was appropriated for the removal of the great Red River raft. This obstruction consisted of a mass of sunken logs and stumps filling the entire channel of the river and extending a distance of 92 miles from Loggy Bayou, 65 miles below Shreveport, La., to Hurricane Bluffs, 27 miles above. A channel was opened through the raft, but owing to the failure of appropriations between 1841 and 1852 another raft formed. By river and harbor act of August 30, 1852, $100,000 was appropriated and the river was opened to commerce. This amount, however, was not sufficient to complete the work, and in 1857 a recommendation was made that $50,000 a year be appropriated for completion and maintenance. No more funds were provided, however, until 1872, and in the interval the greater portion of the result of the former work was lost.

When work was resumed in 1872 the river above Shreveport, La., was closed by a raft 32 miles long, which was constantly increasing. Below Shreveport the enlargement of an outlet through Tones Bayou depleted the main channel and threatened to render it unnavigable. The falls at Alexandria, La., caused by a ledge of rock extending across the stream, were impassable at low stages. The channel of the river frequently changed its location and the constant caving of the heavily timbered banks brought numerous snags and logs into the stream, which made navigation difficult and dangerous throughout the entire river at all stages of water.

The project adopted by river and harbor act of June 10, 1872 (based on report printed in S. Ex. Doc. No. 71, 42d Cong., 2d sess.), contemplated opening a channel for navigation through the raft at an estimated cost of $259,014 and from $10,000 to $50,000 per annum for maintenance and closing Tones Bayou outlet. River and harbor act of June 18, 1878, provided funds for removal of wrecks, snags, and other obstructions from the river below Shreveport, and the

Digitized by Google

same kind of work was directed for the part of the stream above the head of the raft to Fulton by the act of March 3, 1879 (based apparently on report printed in S. Ex. Doc. No. 42, 45th Cong., 3d sess.). A channel was cleared through the raft in 1872–73, and subsequent work prevented new formations of the same nature, increased the width of the river 100 feet or more, and greatly improved the navigable channel. This work also lowered the bed of the stream and relieved vast areas of fertile land from overflow. Several attempts were made to close Tones Bayou outlet, but owing to the inadequate funds and the determined opposition of residents of the vicinity they did not succeed. This outlet, however, gradually filled from natural causes, and was finally closed by the parish levee board.

By the river and harbor act of August 2, 1882, the entire river from Fulton, Ark., to the Atchafalaya River, La., was included in one project. Under the river and harbor act of July 5, 1884, the revetment of the bank at Alexandria, La., and the closure of Sale and Murphy outlet were authorized. The river and harbor act of August 5, 1886, directed a complete survey of the portion of Red River included in the project and also a survey of Bayou Pierre, La. The improvement of Cypress Bayou and the lakes between Shreveport, La., and Jefferson, Tex., and of Bayou Dorcheat, La., was added to the project by the river and harbor act of August 11, 1888; and a provision in the river and harbor act of September 19, 1890, required the widening and deepening of a part of Red River known as Little River from Scopini Cut-off to Knox Point. This work was all practically completed when the existing project was adopted July 13, 1892.

2. OUACHITA AND BLACK RIVERS, ARK. AND LA.

The original project for this improvement was adopted by river and harbor act approved March 3, 1871, and contemplated removing snags and other obstructions and dredging the worst bars between Arkadelphia, Ark., and Trinity, La. (This project was based on plan contained in H. Ex. Doc. No. 60, part 4, 41st Cong., 3d sess.)

By river and harbor act approved June 10, 1872, a project was adopted providing for a system of 10 locks and dams with an average lift of 14 feet each to give a usable depth of 4 feet or more between the mouth of Ouachita River and Camden, Ark., throughout the year, in accordance with plan contained in Report Chief of Engineers, 1872, page 367. A new survey was made in 1874 (Report of Chief of Engineers, 1874, p. 352), and this project was abandoned on account of many errors which were discovered in the plans and because the bar which then formed at the mouth of Red River during low water would have prevented steamboats from reaching Ouachita River at the time of year when the locks and dams would be in use.

The project adopted by river and harbor act approved August 14, 1876, contemplated the removal of snags, logs, wrecks, leaning timber, etc., on the Ouachita River between Camden, Ark., and Trinity, La., a distance of 294 miles. The river and harbor act approved July 5, 1884, added Black River, between Trinity, La., and its mouth, 56.8 miles long, to the project, and directed work of a similar character therein. Operations under this project were continued until

Digitized by Google

1902 with great benefit to navigation. The rivers were kept free from obstructions, and steamboats were enabled to run with safety at any stage of water high enough to allow them to pass the shoals.

By river and harbor act of June 13, 1902, a project was adopted based on plan contained in House Document No. 448, Fifty-seventh Congress, first session (Report of Chief of Engineers, 1902, p. 1435), for the construction of nine locks and movable dams with available lock chamber dimensions of 365 by 49 feet and depths over miter sills of 6½ feet. The original estimated cost of the entire system was $1,998,576. This project was modified before completion of any of the locks and dams by eliminating Lock and Dam No. 1 and by changing dimensions of lock chambers, and is now the present project.

4. OUACHITA RIVER ABOVE CAMDEN TO ARKADELPHIA, ARK.

This work was originally included in the project for the improvement of the river between Arkadelphia, Ark., and Trinity, La., in accordance with plan contained in House Executive Document No. 60, part 4, Forty-first Congress, and adopted by the river and harbor act approved March 3, 1871. This project provided for removing snags and other obstructions and for dredging, and considerable work was done under it, but work on this particular part of the river was discontinued after 1874, and not resumed until 1888.

In 1888 the river and harbor act approved August 11, 1888, adopted a project based on report of examination printed in Annual Report of the Chief of Engineers for the year 1887, page 1495. This project provided for the removal of snags, logs, and overhanging trees, and for building brush dams to scour the channel at shoals, at an estimated cost of $9,000. This project was reported as completed in November, 1890. (Annual Report for 1891, p. 239.)

The existing project was adopted by the river and harbor act approved June 25, 1910, which provided as follows:

> Improving Ouachita River, Ark. and La., by removing snags, leaning trees, and other obstructions between Camden and Arkadelphia, in the State of Arkansas, $10,000, or as much thereof as may be necessary.

The river and harbor act approved March 3, 1909, had directed the examination of this portion of the Ouachita, but the project outlined in the previous paragraph was adopted by Congress prior to the submission of the report on this examination, which was not forwarded by the Secretary of War until March 1, 1912. The report on this examination is printed in House Document No. 588, Sixty-second Congress, second session.

5. SALINE RIVER, ARK.

The original project for improvement of this river was based on report of examination published in Report of the Chief of Engineers for 1879, page 1003. This project was adopted by the river and harbor act of June 14, 1880, and contemplated the removal of snags, sunken logs, etc., from the channel of the stream and leaning trees along the banks from the mouth of the river to Big Island, about 260 miles above. From 1886 until 1910 no work was done on this river. In the latter year Congress provided for completing the improvement in accordance with report submitted in House Document No.

Digitized by Google

1212, Sixtieth Congress, second session. This document recommended a renewal and continuation of operations under the previous project between the mouth of the river and Turtle Bar, which is 135 miles above the mouth, at an estimated first cost of $5,400 and an annual maintenance cost of $3,000 thereafter.

6(*c*). TENSAS RIVER AND BAYOU MAÇON, LA.

The original project adopted by river and harbor act of March 3, 1881, contemplated the improvement of Tensas River from its mouth to Dallas, La., about 138 miles, by the removal of snags, sunken logs, and leaning timber. By the river and harbor act of July 5, 1884, the improvement of Bayou Macon from its mouth to Floyd, La., about 112 miles, was added to the project, and the same class of work was proposed therein. The project for both of these streams was based on reports of examinations contained in House Executive Document No. 38, Forty-sixth Congress, third session. The work under this project in Tensas River was practically completed to Westwood Place, 81 miles above the mouth, in 1898, and in Bayou Maçon to Floyd in 1899.

6(*d*). BAYOUS D'ARBONNE AND CORNEY, LA.

The original project for these streams was adopted by river and harbor act approved July 5, 1884, and provided for the removal of snags, logs, stumps, and leaning trees between the mouth of Bayou D'Arbonne and Stein Bluff on Bayou Corney, a distance of 40.5 miles, at an estimated cost of $15,000. This project was based on a report of examination printed in Senate Executive Document No. 69, Forty-eighth Congress, first session. This project was modified by the river and harbor act of July 13, 1892, which provided for extending operations up Bayou Corney to Cobb Landing, 19.3 miles above its mouth. The river and harbor act of August 18, 1894, provided for work of the same character in Little D'Arbonne. The work in Little D'Arbonne was finished in 1895, and the project for Bayous D'Arbonne and Corney was practically completed in 1896.

7(*a*). YAZOO RIVER, MISS.

The original project was adopted by the river and harbor act of March 3, 1873, and appears to have contemplated the removal of the eight wrecks of those sunk during the Civil War that constituted the worst obstructions to navigation, at an estimated cost of $40,000. Under this project nine wrecks were removed by February 1, 1874.

7(*c*). BIG SUNFLOWER RIVER, MISS.

The original project for this improvement adopted by the river and harbor act approved March 3, 1879, was based on an examination, the report on which was printed in Senate Executive Document No. 42, Forty-fifth Congress, third session, and contemplated removing snags, sunken logs, leaning timber, etc., and building pile and brush wing dams to scour the channel at the shoals between Clarksdale and the mouth of the river, about 196 miles. Estimated cost, $66,000.

Digitized by Google

7(e). STEELE AND WASHINGTON BAYOUS AND LAKE WASHINGTON, MISS.

The original project for this improvement was adopted by river and harbor act approved July 5, 1884, and contemplated removing snags, sunken logs, and leaning trees in Steele Bayou, Miss., from Swan Lake to the mouth of the bayou, a distance of about 85 miles. This project was based on a report of examination which was printed in Annual Report, Chief of Engineers, 1884, page 1360. By the river and harbor act of August 5, 1886, Washington Bayou, about 7 miles long, which connects Steele Bayou and Lake Washington, was added to the project. Work under this project was discontinued in 1896, recommendations to this effect having been made for several years preceding, and was not resumed until after the adoption of the existing project by the river and harbor act of June 25, 1910.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE LITTLE ROCK, ARK., DISTRICT.

---

1. ARKANSAS RIVER, ARK. AND OKLA.

The first project for the improvement of the Arkansas River was adopted by river and harbor act of July 3, 1832, in the following item:

> For improving the navigation of the Arkansas River, $15,000: *Provided*, The engineer department, after due examination, is satisfied that during a portion of the ensuing year the men and machine now employed in removing obstructions in the Ohio and Mississippi Rivers can be more usefully employed in removing those of the Arkansas River.

Many of the earlier appropriations for this work were combined with appropriations for similar work on other streams. The title of the appropriation finally became "Removing snags, wrecks, and other obstructions in Arkansas River, Arkansas." The work was that of removing snags, overhanging timber, bowlders, and reefs, and cutting out sand bars by temporary wing dams. The extent of the work was throughout the river from its mouth to Fort Smith, 369 miles. By river and harbor act of July 5, 1884, this project was merged with one adopted by river and harbor act of March 3, 1879, reference to which is made in the second paragraph following.

The river and harbor act of March 3, 1879, adopted a project for improvement between Fort Smith, Ark., and Wichita, Kans., based on report of examination printed in House Document No. 94, Forty-fifth Congress, third session. The work contemplated was that of removing snags and constructing light wing dams at some of the worst shoals. The estimated cost was $100,000, to be expended in one season. Recommendation was made that $16,350 be appropriated for a survey of the river between the limits stated, a distance of 403 miles.

The river and harbor act of July 5, 1884, adopted a project for removing obstructions in the Arkansas River from the mouth to Wichita, Kans., and thus merged the 1832 project and the 1879 proj-

Digitized by Google

ect by making the one project for the same class of work extend over the limits of river that had heretofore been covered by those two projects, a total distance of 772 miles. This project continued as a separate one until by river and harbor act of July 13, 1902, it was merged with the permanent improvement project. Abstracts of work done under this project to June 30, 1896, inclusive, are printed on page 1650 of the Annual Report of the Chief of Engineers for 1896.

The river and harbor act of August 14, 1876, authorized the removal of the bar at Fort Smith, Ark., at a cost of $10,000. The river and harbor act of June 18, 1878, appropriated an additional $10,000, by which the project was completed. The original condition was: A bar joining the right bank of the river had formed to such an extent that the main channel of the river was next to the left bank, thus preventing boats from reaching the Fort Smith shore during ordinary low or lower stages of the river. The work undertaken was that of building from the left bank a brush and stone dike 1,100 feet long, and thence a training wall extending downstream 1,100 feet, approximately parallel to the right bank. The object sought was to hold the channel against the right bank along the Fort Smith wharf.

The river and harbor act of July 5, 1884, appropriated $5,000 for the protection of the harbor at Fort Smith, Ark., in accordance with a report printed on pages 1397–1398 of the Annual Report of the Chief of Engineers for 1884. Here the right bank of the river just below the steamboat wharf was subjected to slight erosion during high water to arrest which small spur dikes had been built by the Fort Smith Oil & Compress Co. The work accomplished under this project was that of building an additional spur dike 181 feet long to the height of the 12-foot stage, enlarging the larger of the two original dikes by raising its height to the 8-foot stage and increasing its length by 40 feet.

The river and harbor act of June 14, 1880, adopted a project for improvement at Pine Bluff which had three objects in view: First, to protect the bank immediately in front of the town of Pine Bluff from further erosion; second, to rectify the course of the river in the bend above the town in order to remove a bar which was an impediment to navigation, and also, by diminishing the curvature of the bend, to lessen the tendency to excessive scour in front of the town; third, to prevent the formation of a cut-off threatened across the neck of the peninsula opposite Pine Bluff, which, if allowed to take place, would have left the town nearly 4 miles from the river, with injurious effects on the river above and below; the work to be accomplished by means of revetments to stop the erosion of the banks, and by means of dikes to rectify the course of the river in the bend above town. The estimate was:

For revetting 36,000 feet of bank, at $2.50 per foot	$90,000
For constructing 2,000 feet of floating brush dike, at $1 per foot	2,000
For superintendence and contingencies	8,000
Total	100,000

This work continued as a separate local project until it was absorbed in that for the permanent improvement of the river by the river and harbor act of August 5, 1886.

Digitized by Google

The first project looking toward the general improvement of the river by permanent works was adopted by the river and harbor act of August 5, 1886, in accordance with the plan and recommendations in Appendix V–13, Executive Document No. 1, Forty-ninth Congress. The plan set forth in Appendix V–13 (Annual Report for 1885, p. 1902) contemplated securing a channel at least 200 feet wide and 6 feet deep at low water, between the mouth of the river and Little Rock, 174 miles, by contracting the water width by primary and secondary hurdles similar to those used on the Mississippi River in the vicinity of St. Louis, Mo. The estimated cost of the work was $2,538,544. This project was modified and extended by the river and harbor act of August 11, 1888, which adopted a project for the improvement of the entire river and consolidated with it all the local works theretofore done or then in progress (excepting the work of removing snags, etc., which was continued as a separate project), in accordance with the reports printed in the Annual Report of the Chief of Engineers for 1885, and in House Executive Document No. 90, Forty-ninth Congress, first session; such methods to be applied as the Secretary of War may direct, at points between Wichita, Kans., and the navigable mouth of the Arkansas River, as he may deem for the best interests of commerce.

Although that act designated Wichita, Kans., as the upper limit of the work, no estimate had been submitted for improvement above Arkansas City, Kans., 71 miles below Wichita. The estimates submitted for the permanent improvement of the river from the mouth to Arkansas City were three in number, thus:

Mouth to Little Rock (Annual Report, 1885, p. 1603)	$2, 538, 544
Little Rock to Fort Gibson (Annual Report 1888, p. 1386)	1, 307, 935
Fort Gibson to Arkansas City (H. Doc. No. 90, 49th Cong., 1st sess.)	1, 696, 900
Total	5, 543, 379

The plans on which these estimates were based were for removal of rock and gravel reefs by blasting and dredging, contracting the waterway by permeable dikes, as used on the Mississippi River, or by brush and stone wing dams and protection of caving banks, no mention of revetments being made, except by implication in the references to the works on the Mississippi. An abstract of the works built prior to 1899 for the permanent improvement of the river, together with a statement of their costs, is given on pages 2151–2154 of the Annual Report of the Chief of Engineers for 1901. A more detailed description of most of said works is given on pages 1652–1657 of the Annual Report of the Chief of Engineers for 1896.

The "permanent improvement" project of August 11, 1888, and the "removing obstructions" project of July 5, 1884, were merged by act of June 13, 1902, into the present project.

2. WHITE RIVER, ARK.

Although examinations of this stream, in connection with examinations of St. Francis and Black Rivers, were authorized by the river and harbor acts of March 3, 1833, July 4, 1836, and March 3, 1837, the first work for its improvement appears to have been undertaken in 1870, in connection with snagging operations on the Mississippi River, when the snag boat *R. E. DeRussy* worked a portion

Digitized by Google

of the summer below Devall Bluff. (Annual Report, 1871, p. 376.) The river and harbor act of July 11, 1870, authorized an examination under which the river was investigated from Forsyth, Mo., to the mouth. (Annual Report, 1871, p. 364.) The river and harbor act of March 3, 1871, made appropriation for improvement in connection with the improvement of Black and Little Red Rivers. This being the first direct appropriation for improvement, the date of that act is considered to be the date of the original project. The funds appropriated were expended in snagging operations, those on the White being limited to the river below Jacksonport. The river and harbor act of March 3, 1873, combined the snagging operations on White River below Jacksonport with those on the St. Francis River. This combination remained in effect until the river and harbor act of July 5, 1884, which carried separate appropriations for the streams named.

The river and harbor act of June 23, 1874, appropriated "For continuing the improvement of the White River above Jacksonport." This appropriation was expended in removing snags, leaning trees, and loose bowlders between Jacksonport and Buffalo Shoals. The river and harbor act of August 14, 1876, made appropriation for the improvement of the river at Buffalo Shoals. As was the case in all prior appropriation acts for this stream, there was no reference to plan, report, or examination. The plan followed was that of building wing dams to hold and deepen the water at the shoalest places in connection with the removal of rock and bowlders to the end of securing a clear channel 200 feet wide. Map of the locality is given in the Annual Report of the Chief of Engineers for 1878, page 662. Three wing dams were constructed from the funds derived from the 1876 appropriation. The river and harbor act of March 3, 1879, made appropriation "For improving White River," no limits being stated. This was expended between Jacksonport and Buffalo Shoals (Annual Report, 1888, p. 153) in the construction of three wing dams, in the removal of rock from Buffalo Shoals, and in similar work on shoals below, with the object of providing a good navigable channel in the upper White River available throughout the entire season. (Annual Report, 1880, pp. 153–154.) The river and harbor act of June 14, 1880, made further appropriation for improving the river above Buffalo Shoals. Examinations of and reports on this part of the river had been made in 1871 and 1872. Work under this 1880 appropriation, however, was not begun until a new examination could be made. Thereafter the plan followed was that of extending upstream on three shoals the work which had been done at Buffalo Shoals.

The river and harbor act of July 5, 1884, consolidated the snagging operations below Jacksonport with the work of permanent improvement between Jacksonport and Buffalo Shoals and that above Buffalo Shoals, and provided for a survey of the river from Forsyth to the mouth in order that a definite plan and estimate of the cost for the improvement of the river might be formulated. Such a plan, referred to in annual reports as "the project of 1888," was to deepen the water on the shoals by contraction works and to remove rock, bowlders, and snags from the channel, the object being to obtain a 5-foot depth at low water from the mouth of the river to Newport and 2-foot depth from there to Buffalo Shoals, at an estimated

Digitized by Google

cost of $105,815 for permanent works, and an additional expenditure of $8,000 a year for two or three years for snagging operations after the permanent works had been completed. (Annual Report, 1888, p. 1406.) For the reasons stated in the Annual Report of the Chief of Engineers for 1891, page 2049, the estimate was inadequate to accomplish the object sought. The river and harbor act of July 13, 1892, appropriated $53,815 to complete the project, and an additional sum of $21,185 to be expended in the discretion of the Secretary of War. The "additional sum" and funds provided in subsequent appropriations were expended along the lines of the project of 1888, with the addition of dredging between Batesville and Jacksonport in 1897. No permanent works for open-channel improvement have been built since the fiscal year 1896. An abstract of the work done prior to and including that of 1896 is printed on pages 1668–1874 of the Annual Report of the Chief of Engineers for 1896, and a statement of the results accomplished above Batesville is given on pages 1680–1682 of the said report. The river and harbor act of March 3, 1899, adopted a lock-and-dam project for the improvement of the river above Batesville. The appropriation made by that act for open-channel improvement was "for completion." However, the river and harbor act of June 13, 1902, provided for continuing the improvement of White River without reference to plan or estimate. From this it has been held that the existing project for the maintenance of channel below Batesville dates from the river and harbor act of March 3, 1899.

The lock-and-dam project adopted by the river and harbor act of March 3, 1899, was based upon a report printed in the Annual Report of the Chief of Engineers for 1897, page 1902, and was to provide slackwater navigation from Batesville to Buffalo Shoals, 89 miles, by 10 fixed dams with concrete locks, at a total estimated cost of $1,600,000. The locks were to be 175 feet between quoins, 36 feet wide in the chamber, with 4-foot depth on the miter sills. Three of the locks and dams have been constructed, at a cost of $813,774.51, and are being operated and cared for under the indefinite appropriation "Operating and care of canals and other works of navigation." A board of engineers, appointed pursuant to the requirements of the river and harbor act of March 3, 1905, reported that the construction of further locks and dams was not desirable (H. Doc. No. 150, 59th Cong., 1st sess.), and the project has been abandoned, the appropriation item in the river and harbor act of March 3, 1907, being "Completing improvement by the construction of Lock and Dam No. 3 * * *."

3. WHITE RIVER AT DEVALL BLUFF, ARK.

This is a local work to prevent a cut-off in White River near Devall Bluff, Ark. The first appropriation was made by the river and harbor act of June 13, 1902, which provided that $7,500 of the amount appropriated for White River might, if required in the interest of navigation, be used to prevent cut-off between Choctaw Railway bridge and Devall Bluff. Nothing was undertaken under the special authority referred to, and the fund was utilized for the general purposes of the river. The question of cut-off near Devall Bluff was revived by the river and harbor act of March 4, 1913, which adopted the present project.

Digitized by Google

4. OPERATING AND CARE OF LOCKS AND DAMS NOS. 1, 2, AND 3, UPPER WHITE RIVER, ARK.

The project for the construction of these locks and dams was adopted by the river and harbor act of March 3, 1899. The plan (H. Doc. No. 78, 54th Cong., 2d sess.) proposed slackwater for 4-foot navigation from Batesville, Ark., to Buffalo Shoals, Ark., 89 miles, by the construction of 10 locks and dams, at an estimated cost of $1,600,000. The locks were to be of concrete masonry with wooden gates; the dams were to be of timber cribs, stone filled. The average lift of each of the locks was fixed at 14.5 feet. The river and harbor act of March 2, 1907, abandoned the original project, appropriating for the completion of the improvement by the construction of Lock and Dam No. 3. This action was based on a report by a board of engineers published in House Document No. 150, Fifty-ninth Congress, first session. Since the completion of Lock and Dam No. 3 the project has been for maintenance of the several works under the appropriation "Operating and care of canals and other works of navigation, indefinite."

5. CACHE RIVER, ARK.

The original project, based on a report printed on page 1547, Annual Report of the Chief of Engineers for 1887, and adopted by the river and harbor act of August 11, 1888, provided for the building of a small hand-propelled snag boat and working it from Riverside to the mouth of the river (102 miles), at an estimated cost of $7,000. The estimate was inadequate, and $2,000 additional was appropriated by the river and harbor act of July 13, 1892. An additional $2,000 was derived from the sale of the boat. The expenditure of these additional funds completed the project. The operations indicated secured a fair channel for navigation at medium stages.

The river and harbor act of August 14, 1894, authorized allotment from the White River appropriation to this river for the purpose of removing obstructions, without reference to limits of work or estimate of cost. Subsequent river and harbor acts having made appropriations, either by allotment or direct, for the same purpose, that date (Aug. 14, 1894) is held to be the date of the present project.

6. BLACK AND CURRENT RIVERS, ARK. AND MO.

(*a*) BLACK RIVER.

The improvement of Black River appears to have been first authorized by the river and harbor act of March 3, 1871, which appropriated funds for the joint improvement of White, Black, and Little Red Rivers, without a stated distribution. The work proposed appears to have been snagging operations. But a very small amount of the joint fund was spent on Black River. The report on the work accomplished under the appropriation states that the snag boat could get but a short distance above the mouth of Black River owing to the lack of water and to acute bends. (Annual Report, 1872, p. 343.) The river and harbor act of June 14, 1880, made the first separate appropriation for this river and adopted the present project.

Digitized by Google

(b) CURRENT RIVER.

The original project adopted by the river and harbor act of June 10, 1872, contemplated the removal of snags and leaning timber and the construction of wing dams at certain of the shoals. A report of an examination made in 1871 (Annual Report, 1872, p. 395) gives an estimate of $25,722.62 as the amount required for the improvement of the river from Van Buren to the mouth. The act referred to appropriated $5,000. This, with a sum of $20,000 appropriated by the State of Missouri, covered the estimate referred to (Annual Report, 1873, p. 460). The river and harbor act of March 3, 1881, adopted a project for the improvement of the river from Doniphan to the mouth. This, like the former project, contemplated improvement by means of wing dams to concentrate the water over the shoals and by the removal of snags, logs, and overhanging timber. The estimated cost of the improvement was $17,365. The appropriation was $2,000. With the expenditure of the appropriation named, nothing further was undertaken until the adoption of the present project.

7. ST. FRANCIS AND L'ANGUILLE RIVERS AND BLACKFISH BAYOU, ARK.

(a) ST. FRANCIS RIVER.

The original project for the improvement of St. Francis River, adopted by the river and harbor act of March 3, 1871, apparently was based upon the report of an examination printed on page 356 of the Annual Report of the Chief of Engineers for 1871, as that report recommended the removal of snags and fallen trees between the mouth of the river and Wittsburg, and the work undertaken was along those lines. The river and harbor act of March 3, 1873, combined snagging operations on the St. Francis River with similar work on the White River; operations on White River being limited to below Jacksonport, and those on St. Francis River to below Wittsburg (Annual Report, 1873, p. 492). This combination of work continued until the two rivers were separated by the river and harbor act of July 5, 1884.

The river and harbor act of June 14, 1880, adopted a project for the improvement of the St. Francis River from Wittsburg to Lesters Landing by the removal of such obstructions as interfered with the safe navigation of the river and "the lake." Through "the lake" it was proposed to cut out and properly mark a channel so as to designate to steamboats the proper route. (Annual Report, 1880, part 2, p. 159.) The first separately adopted project for the improvement of the entire river was that adopted by the river and harbor act of July 5, 1884. This contemplated the improvement of the river from its mouth to St. Francis, Ark., by snagging operations and by closing chutes and sloughs in the St. Francis sunken lands, so as to make the river navigable at high stages through the latter, at medium stages to Marked Tree, and at low stages to a point 30 miles below Madison, Ark., at an estimated cost of $8,000 annually for maintenance. The act of August 11, 1888, adopted a project for the improvement of the St. Francis River in Missouri, this being the section above the sunken lands. Upon the adoption of that project Ken-

Digitized by Google

nett, Mo., 25 miles below St. Francis, was taken as the head of improvement for St. Francis River, Ark., in order to avoid confusion or overlap as to the limitation of the project for the improvement of the St. Francis River, Mo. This project continued until by the river and harbor act of June 13, 1902, its scope was enlarged to that of the present project, which includes the L'Anguille River up to Marianna. An abstract of the work done prior to the fiscal year 1896 is given on page 1692 of the Annual Report of the Chief of Engineers for 1896.

(*b*) L'ANGUILLE RIVER.

The original project, which was for improvement by snagging operations, at an estimated cost of $15,000, was adopted by the river and harbor act of June 18, 1878. Appropriations ceased with that made by the river and harbor act of June 4, 1880. The river and harbor act of June 13, 1902, enlarged the St. Francis River project to include this stream.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE ST. LOUIS, MO., DISTRICT.

---

1. IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS.

Project of 1872, superseded 1881; project of 1881, revised 1883; modified 1895, 1896, 1902, 1905, 1906, 1907, and restored, together with dredging, 1910.

In its original condition, prior to any improvement, the navigable channel of the Mississippi River at low water had a natural depth in many places of only 3½ to 4 feet. The main channels were divided by islands and bars, which formed chutes, sloughs, and secondary channels, through which considerable parts of the low-water flow were diverted, to the detriment of navigation.

The first appropriation for work of improvement was included in the river and harbor act, July 4, 1836, "for a pier to give direction to the current of the Mississippi River, near the city of St. Louis," and subsequently, 1837 and 1844, other appropriations were made for work in the harbor of that city. In 1852 an appropriation was made for work on the Mississippi River between St. Paul and the Ohio River. The expenditures within this district under these old appropriations are now not known.

The original project for the general improvement of the river in this engineer district for the benefit of navigation was recommended by a board of engineers in report dated April 13, 1872. Work was begun in that year and continued for a number of years as appropriations were made. The works consisted of solid dikes and dams of brush and stone, to confine the low-water volume of the river to a single channel, and of revetments to hold and preserve the banks from erosion where necessary and advisable to do so.

Under this project work was done at the following localities: Sawyer Bend, Venice, Cahokia Chute, Arsenal Island, Horsetail Bar,

Digitized by Google

Fort Chartres, Turkey Island, Kaskaskia, Liberty Island, Devils Island, and Cairo, and the total amount expended was $1,495,000 for new work.

2. REMOVING SNAGS AND WRECKS FROM THE MISSISSIPPI RIVER BELOW THE MOUTH OF THE MISSOURI RIVER AND OLD AND ATCHAFALAYA RIVERS.

When this work was originally begun the navigation of the river was seriously obstructed by numerous snags, logs, etc., which had lodged in the channel, and to which additions were made with each rise of the river. A large number of wrecks of flatboats, barges, steamboats, and other river craft also obstructed the navigable channels and menaced life and property.

For the removal of these obstructions, appropriations were made as early as 1824. The project adopted consisted of building boats suitable for removing snags, logs, drift heaps, wrecks, etc., and operating them whenever the stage of the river was favorable and funds were available, and in cutting trees from caving banks to prevent their falling into the river and becoming obstructions to navigation.

Appropriations for this work were made at irregular intervals in lump sums, under the general style of "Western rivers, dredging, removal of snags, wrecks, and other obstructions, including Arkansas, Mississippi, Missouri, and Ohio Rivers."

In the river and harbor act approved March 3, 1879, the first definite allotment to each river was made, and work was done under these uncertain appropriations until August 11, 1888, when the present project was placed on a definite basis by the adoption of the river and harbor act of that date, which provided a definite annual amount, $100,000, for removal of obstructions in the Mississippi River below the Missouri River.

The approximate amount expended on the previous projects to March 3, 1879, was $358,627.35, and the work done to that date was 12,003 snags destroyed, 53,299 trees cut, 82 drift piles destroyed, and 1 wreck removed.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE ROCK ISLAND, ILL., DISTRICT.

MISSISSIPPI RIVER.

1. *Rock Island Rapids improvement, Mississippi River.*—The Rock Island Rapids extend from Le Claire, Iowa, to Rock Island, Ill., a distance of about 14 miles. The initial appropriation for their improvement was made by act of June 23, 1866. A board of engineers in 1866 advised the cutting of a channel through the chains of rock. Based on a survey of Capt. P. C. Hains, Corps of Engineers, made in 1866, the original project was approved. This project contemplated "the connection of the deep pools by channels cut through the chains 200 feet wide with depth of 4 feet at low water." These plans were carried out and virtually completed in 1882. A full report of this improvement is in Annual Report of the Chief of Engineers for 1886,

Digitized by Google

pages 1429 to 1465. As the work progressed, additional fields and patches of rock were found, increasing the rock excavation from the estimated 57,451 cubic yards to 87,926, and the cost from $813,601.80 to $1,166,608.50. This work extended over a period of 16 years.

(*a*) Additional project by board of engineers, January 16, 1889, report of the Chief of Engineers, page 1751 et seq., which included widening of the cuts in the bends, dam construction, piers for channel guides, and sand dredging at an estimated cost of $328,900. This project was not entirely carried out and was merged in the current 6-foot channel project adopted in 1907. The work was changed and much increased and $694,856 had been expended before the work was discontinued. All of the work proposed by the board was carried out at a less cost than estimated.

2. Improving Des Moines Rapids—Des Moines Rapids Canal.—This improvement, like that of the Rock Island Rapids, was considered by a board of engineers in 1866 (Annual Report of the Chief of Engineers for 1867), and the plan recommended and adopted provided for the building of a closed lateral canal 8 miles long, and for the cutting of an open channel in the rock bed of the river over the remaining 4 miles of rapids which extended from Montrose to Keokuk. The prism of the canal to be 200 feet in width in its narrowest parts and 5 feet in depth, with 3 locks, 350 feet by 80 feet in the chamber, with lifts varying with the river stage surmounting a fall of 19 feet at low water. The open canal to be 200 feet wide and 5 feet deep at low water. This work, with its modifications, was not entirely completed until 1894, although the canal was opened in 1877. The initial appropriation, $200,000, was made by river and harbor act of June 23, 1866. The original estimate was $2,530,000; its actual cost, $4,574,950. The cost was increased by delayed appropriations and heavy losses due to high water. The quantities were greatly in excess of the original estimate. This improvement was made obsolete by the construction of the power dam at Keokuk, which provides a single lock 400 feet by 110 feet, with an extreme lift of 40 feet and a controlling depth on the lower miter sill of 7 feet. This lock was opened to navigation in June, 1913.

3. Flint Creek to Iowa River Levee.—The river and harbor act of August 18, 1894, provided for a survey on the west side of the Mississippi River from Flint Creek to Iowa River, "with a view to improving the navigation by preventing the water from overflowing the natural and artificial banks along those parts of the river and deepening the channel." The report (H. Ex. Doc. No. 161, 53d Cong., 3d sess.) proposed a levee 42 miles long, including cross levees on both sides of De Soto Creek. These cross levees were afterwards omitted, reducing the length to about 35 miles. Estimates were made for an earthern bank with a slope of 3 on 1 on the river side and 2 on 1 on the back side, with 4 feet width of crown. Grade, 3 feet above high water of 1888. Estimate for 1,855,193 cubic yards earthwork, $305,000. Congress adopted this project in the sundry civil act of March 2, 1895, and the work was completed in 1900, a total of $300,000 having been appropriated. These funds completed the levee with about the same quantity of earthwork as estimated, besides providing for the surveys, right of way (mostly donated), gravity drainage, superintendence and inspection, repair and mainte-

Digitized by Google

nance, revetment of 15,000 linear feet of levee bank and 6,876 linear feet of shore protection. A full and final report on this levee is in Annual Report of the Chief of Engineers for 1902, pages 1637 to 1646. Since the levee was completed, about $36,000 has been expended for earthen reinforcement of bank and for shore protection.

4. *Mississippi River improvement at Moline, Ill.*—The river and harbor act of June 13, 1902, provided for examination and survey of Mississippi River at Moline, Ill., with a view to the construction of a lock. The report (H. Doc. No. 397, 58th Cong., 2d sess.) presents a plan and estimate for 4 feet depth in channel as follows: Lock (350 feet by 80 feet by 6 feet controlling depth), $185,000; dam, $19,216; rock excavation $141,572; contingencies $42,217; total $386,005. Congress adopted the project in the sundry civil act of March 3, 1905, and in that and the two following years appropriated the full amount. The work was completed in 1909 and although some changes were made in location of lock and dam, involving an increase in rock excavation, earthwork and masonry, the estimate was not exceeded.

5. *Improving Mississippi River, Missouri River to Minneapolis.*—The river and harbor act of June 18, 1878, appropriated funds for improvement of Mississippi River, widening and deepening the channel from St. Paul to Des Moines Rapids; also for same purposes from Des Moines Rapids to mouth of the Ohio. No surveys or projects had been rendered prior to above date, but a continuous survey from St. Paul to the Illinois River was made in 1878–79. No project and estimate for this entire work was ever rendered, it being thought best to present projects from year to year, selecting points known to be most troublesome. (Annual Report for 1879, p. 1498.) This method ceased in 1907, when the 6-foot project and estimate of $20,000,000 were adopted. The original project and subprojects were intended to provide a channel 4½ feet deep at low water of 1864. The appropriations 1878 to 1907 aggregated $12,157,500.02.

6. *Harbor at Rock Island, Ill.*—The river and harbor act of March 3, 1879, provided for a survey of Rock Island Harbor. The report (H. Doc. No. 32, 46th Cong., 2d sess.) presented a plan for dredging along the harbor front and on the middle ground bars at an estimated cost of $26,759.15. The river and harbor act of June 14, 1880, adopted the project and appropriated $6,000, which was followed by an additional appropriation of $6,000 in the river and harbor act of March 3, 1881.

(*a*) *Additional project.*—The river and harbor act of June 3, 1896, allotted $5,000 for maintenance. A project was prepared in that year for rock excavation to a grade of 4 feet at low water from Seventeenth to Twentieth Streets at an estimated cost of $25,000. Only $10,000 was appropriated and work ceased in 1898.

7. *Harbor at Muscatine, Iowa.*—A survey was made by order of the Chief of Engineers subsequent to the initial appropriation made in the river and harbor act of March 3, 1879. The project contemplated dredging along the steamboat landings at a cost of $19,250. Funds appropriated ($20,000) were expended in 1883, the work originally contemplated having been performed and some additional dredging.

(*a*) *Supplementary.*—Sundry civil act of June 4, 1897, appropriated $15,000 for dredging to a 6-foot depth at low water along

Digitized by Google

the river front from the bridge to below Pine Street. Work completed in 1898 under appropriations aggregating $25,000. Sand and gravel removed, 89,590 cubic yards.

(*b*) *Supplementary.*—The river and harbor act of June 13, 1902, appropriated $10,000 for improvement of harbor at Muscatine, Iowa. No prior reference to this office or survey. Project in 1904 for shore protection and dredging; completed in 1910.

NOTE.—Appropriations were made for Muscatine Harbor 1879–1902, without prior examinations or surveys, to the amount of $45,000. Estimates were made chiefly for dredging to fit the appropriations in terms "so much as funds will permit."

8. *Mississippi River at Andalusia, Ill.*—River and harbor act of June 14, 1880, ordered survey. The report (H. Ex. Doc. No. 37, 46th Cong., 3d sess.) presented a project and estimate for construction of 3 dams and 900 linear feet of shore protection at a cost of $18,000. Congress, in the river and harbor act of March 3, 1881, approved the project and appropriated $6,000. This amount was amended and subsequently allotments were made from appropriations for general improvement, of which this work is a part.

9. *Ice harbor at Dubuque, Iowa.*—Project December 31, 1880 (H. Ex. Doc. No. 49, 47th Cong., 1st sess.), approved by river and harbor acts of August 2, 1882, and July 5, 1884, appropriating $40,000, the full amount of the estimate, $35,000 of which was for dredging and for riprap $4,500. The latter amount was covered into the Treasury, not being needed for the intended purpose.

10. *Dry dock at Des Moines Rapids Canal.*—Survey ordered by Congress, the report of which (H. Ex. Doc. No. 179, 47th Cong., 1st sess.) recommended a dock 168 feet by 400 feet by 6 feet ruling depth, at a cost of $125,000. Project rendered February 10, 1883; adopted by Congress July 5, 1884. Appropriated, 1884 to 1889, the full amount of the estimate. Completed in 1890 in accordance with original project.

11. *Improving Mississippi River at Louisiana, Mo.*—The report (H. Ex. Doc. No. 37, 46th Cong., 3d sess.) recommended construction of several dams and shore protections, both above and below the bridge, at a cost of $45,000. Project approved by river and harbor act of March 3, 1881, which appropriated $10,000. Subsequent allotments made from general improvement, into which this project was merged.

12. *Mississippi River at Hannibal, Mo.*—The original project for this work, submitted in January, 1880, contemplated, at a cost of $60,000, the removal by dredging of large gravel and mud bars in front of Hannibal and the construction of two spur and one closing dams from the Illinois side to confine the channel to the Missouri shore and prevent the bars from re-forming. This project was made under orders of the Chief of Engineers and was approved by the river and harbor acts of June 14, 1880, and March 3, 1881, appropriating jointly $45,000. This work was then merged in general improvement and the entire project was carried out.

13. *Clarksville Harbor, Mo.*—Survey and estimate ordered by river and harbor act of August 11, 1888. Report and project January 11, 1889. Project included construction of one wing and one closing dam, at a cost of $25,000. Approved by river and harbor act of September 19, 1890, allotting $15,000 from general improvement, in which the project was afterwards merged.

Digitized by Google

14. *La Crosse Harbor, Wis.*—Report ordered by Congress (H. Doc. No. 210, 54th Cong., 2d sess.) recommended a bulkhead 1,575 feet long, another 450 feet long, and dredging; estimated cost, $17,000. Congress approved and appropriated full amount in the river and harbor act of June 3, 1896, and the sundry civil act of March 3, 1899.

15. *Harbors in Lake Pepin—Kings Coulee Pier.*—Report on survey ordered by Congress (H. Doc. No. 52, 52d Cong., 2d sess.) makes project for a pier 770 feet long, with gravel foundation, crest 12 feet above low water, estimated to cost $30,000. Approved by Congress in the river and harbor act of June 3, 1896, allotting full amount. Completed in 1898 under modified project.

16. *Harbors in Lake Pepin—North Pepin Pier.*—Report on survey ordered by Congress (H. Ex. Doc. No. 112, 56th Cong., 1st sess.) recommends a pier 1,000 feet long; core of gravel heavily riprapped; crown 10 feet wide, 12 feet above low water; slope, 1½ on 1. Congress adopted project in river and harbor act of June 13, 1902, and appropriated $14,000, the full amount of the estimate. Project modified for heavier bank and slope 2 on 1. Congress approved and appropriated $11,500 in sundry civil act of March 3, 1905. Total cost of pier, $25,500. Completed, 1908.

17. *Harbors in Lake Pepin—Pier at Stockholm, Wis.*—Report of survey ordered by Congress (S. Ex. Doc. No. 124, 47th Cong., 1st sess.) recommends crib piers, one 1,000 feet long to cost $73,370, and one 500 feet long to cost $34,592. Congress approved project and appropriated $25,000 in river and harbor acts of August 2, 1882, and July 5, 1884. A new project was made, adapted to the funds, resulting in a pier completed in 1884, 579 feet long and 12 feet above low water.

18. *Harbors in Lake Pepin—Pier at Lake City, Minn.*—Report of survey ordered by Congress (S. Ex. Doc. 124, 47th Cong., 1st sess.) recommended two projects, one for a crib pier 1,000 feet long to cost $154,583, and one for a crib pier 500 feet long to cost $53,493. Congress in river and harbor acts of 1882, 1884, and 1886 appropriated $35,000. Project modified in 1887 to a sand foundation. Pier completed in 1887, 870 feet long.

19. *Davenport ice harbor.*—No prior survey. River and harbor act of 1902 appropriated $5,000 and made available $10,000 in the sundry civil act of March 3, 1899, both being allotments from general improvement funds. Project raising dam at head of Rockingham Slough, dredging 54,000 yards, piling and cribs for mooring purposes; work fully completed in 1904 with a balance of $1,953.

20. *Quincy Bay, Mississippi River at Quincy, and Harbor at Quincy, Ill.*—Report on survey ordered by Congress (S. Ex. Doc. No. 53, 45th Cong., 3d sess.) recommended one closing dam and three spur dams for river improvement ($26,000); dredging in Bay, $170,000; riprap, $7,500; total, $223,500. Initial appropriation by Congress in river and harbor act of March 3, 1879. The river improvement was carried out, and up to July 1, 1914, there had been expended for dredging $129,481, about one-third of which was for redredging or maintenance. The project has been changed many times, and all of the original project for the bay is now abandoned except for keeping the lower bay in good condition by timely dredging under the head of maintenance.

Digitized by Google

21. *Rush Chute and Harbor at Burlington, Iowa.*—Special survey under head of "transportation routes to the seaboard" made in 1875. Project called for dams at Rush Chute and dredging. Estimated cost, $35,222. Approved by Congress in the river and harbor act of August 14, 1876, appropriating $10,000. In 1879 project enlarged, adding $20,000 for dams and dredging. In 1881 merged in general improvement. Total of special appropriations $30,000. Work began in 1877.

22. *Mississippi River, vicinity of Fort Madison, Iowa.*—Special survey under head of "Transportation routes to the seaboard" made in 1875. Project called for closing Niota Chute; estimate, $30,187. Approved by Congress in the river and harbor act of August 14, 1876, appropriating $10,000. Total special appropriations, $24,100. Merged in general improvement and completed in 1880. Work began in 1877.

23. *Removing bars in Mississippi River opposite Dubuque, Iowa.*—Board of engineers in 1876 made report, project, and estimate. Project for dredging, $15,000 appropriated by river and harbor act of August 14, 1876. Merged in general improvement with dams and dredging added. Completed in 1881. Total allotments, $41,000.

24. *Mississippi River, North La Crosse to mouth of Root River.*—No survey was made prior to appropriation of $12,500 in the river and harbor act of June 18, 1878. The project comprised two dams to close the chutes opposite La Crosse. Work was done by contract in 1878, and operations in this vicinity were then merged in general improvement.

25. *Cuivre River, Mo.*—The river and harbor act of March 3, 1879, ordered a survey (S. Ex. Doc. No. 36, 46th Cong., 2d sess.). Report, project, and estimate rendered December 29, 1879. The project involved dredging in Cuivre Slough and on four bars in the river, one closing dam, and removal of snags, wrecks, etc., at a cost of $30,000. Congress approved this project in the river and harbor act of June 14, 1880, appropriating $2,000; total appropriations to August 2, 1882, $12,000. Congress afterward declared the river unnavigable, and the improvement was abandoned.

26. *Mississippi River, opposite Guttenberg, Iowa.*—Allotment of $3,000 in the river and harbor act of June 14, 1880, and $5,000 in the river and harbor act of March 3, 1881. No prior survey. Project included a dam across Swift Slough and shore protection on the island. Estimate, $8,000; work completed in 1882. Merged in general improvement of Mississippi River.

27. *Mississippi River at and above Alexandria, Mo.*—Special survey made in 1878 under orders of the Chief of Engineers. Report, project, and estimate January 7, 1879. Proposed work, three spur dams from left bank and one from right bank. Estimate, $30,945. Approved by Congress in the river and harbor act of June 14, 1880, and $10,000 appropriated. Additional appropriation in the river and harbor act of March 3, 1881, $6,000. Project only partially carried out under special appropriations, but was merged in general improvement and afterwards completed.

28. *Mississippi River at Hamburg Bay, Ill.*—Examination ordered by river and harbor act of August 5, 1886, and $10,000 appropriated for work. The report recommended, with an estimate, the expenditure of funds available in dredging a 6-foot channel 240 feet wide

Digitized by Google

through several bars. The work was done in 1886 and 1887. The river and harbor act of June 13, 1902, declares that "Hamburg Bay is hereby included in and made a part of the general improvement of the Mississippi River," but between 1887 and 1902 all dredging work was obliterated. A survey was ordered by sundry civil act of March 3, 1905. (H. Ex. Doc. No. 577, 59th Cong., 1st sess.) This report, project, and estimate, under date of November 29, 1905, describes a plan for dredging, at a cost of $138,800, but all authorities concurred in the opinion that the work was not worthy at the present time, and all improvements of the bay to provide a suitable winter harbor were abandoned.

29. *Mississippi River at Clinton, Iowa.*—In the sundry civil act of March 3, 1899, $25,000 was allotted without prior survey. Adopted project comprised construction of four wing dams and as much dredging as funds would permit. Work was commenced in 1899 and completed in 1908, about as estimated. Now merged in general improvement.

30. *Warsaw to Quincy Levee.*—Report in House Executive Document No. 111, Fifty-third Congress, third session. Project rendered in 1895 covered the reinforcing and rebuilding of the entire levee at a cost of $85,500. The sundry civil act of March 2, 1895, appropriated the full amount of the estimate. Work began in 1895 and was practically completed in 1896. The river and harbor act of June 3, 1896, and the sundry civil act of March 3, 1899, appropriated $5,000 each for repairs.

31. *Mississippi River in the vicinity of Prairie du Chien.*—No survey had been made prior to allotment of $30,000 from the river and harbor act of September 19, 1890. The project rendered in 1891 covered a series of wing dams, of which 15 were built under contract in 1891 and 1892, in accordance with plans and estimate, which latter included as much construction work as funds would permit. Now merged in general improvement.

32. *Mississippi River at West St. Paul.*—No survey had been made prior to an allotment of $15,000 in the river and harbor act of August 2, 1882. Project covered as much dredging as funds would permit. Work was performed by contract in 1885 as projected and estimated.

33. *Galena River, Ill.*—The river and harbor act of March 3, 1873, provided for a survey of "Galena River from its mouth to Galena, Ill." The report in 1873 recommended dredging to 6 feet above low water above the cut-off and 4 feet below, and also a small amount of dredging in Harris Slough. Estimate, $357,000. No consideration was given this project, but appropriations were made for the work, based in part on the project of 1873, aggregating $66,000, 1878 to 1881. About one-third of the dredging was performed, but its effects were very soon eradicated. The river and harbor act of September 19, 1890, authorized the city of Galena to build a lock and dam and agreeing to pay $100,000 when 3 feet depth had been secured during an entire season. This improvement was accepted and paid for in 1894, and since that time has been operated and maintained under the river and harbor acts of July 5, 1884, and March 3, 1909, and such operation and care is the current project.

NOTE.—A large number of small projects carried out by means of allotments from various river and harbor acts, and for which no prior survey or estimate was made, have been omitted.

Digitized by Google

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE ST. PAUL, MINN., DISTRICT.

1. MISSISSIPPI RIVER BETWEEN ST. PAUL AND MINNEAPOLIS, MINN.

This project contemplates the improvement of the Mississippi River between the Chicago, St. Paul, Minneapolis & Omaha Railway bridge in St. Paul and the Washington Avenue Bridge in Minneapolis by means of locks and dams. The matter was first brought to the attention of Congress in 1866, when the Legislature of the State of Minnesota memorialized Congress to make a grant of public lands to aid in the construction by private parties of a lock and dam at Meeker Island, about 2 miles below the Washington Avenue Bridge. By act of July 23, 1868, a grant of 200,000 acres was made for the purpose, subject to the work being done within two years. The conditions not being fulfilled, Congress, by act of March 3, 1873, appropriated $25,000 for a lock and dam at Meeker Island, to be available when formal relinquishment of the land grant had been made. A satisfactory relinquishment not having been made, the appropriation was never used and was covered back into the Treasury in 1885.

By act of August 18, 1894, Congress authorized the construction of Lock and Dam No. 2, as part of the project for two locks and dams, one (No. 1) with a lift of 13.3 feet, to be located just above Minnehaha Creek and 6.34 miles above the Chicago, St. Paul, Minneapolis & Omaha Railway bridge, and the other (No. 2), with a lift of 13.8 feet, to be located about 2.88 miles above No. 1. The locks were to be 80 feet wide and 334 feet long, with a depth of 5 feet on the lower miter sills at low water. The estimated cost of both locks and dams was $1,166,457.

The act of March 3, 1899, authorized the completion of Lock and Dam No. 2 and the construction of Lock and Dam No. 1 by continuing contract. An increase in the limit of cost to $1,466,000 was authorized by the act of March 3, 1905.

The project was modified by the act of March 2, 1907, which required a channel depth of 6 feet, instead of 5 feet. This involved an increase in the lift of the two dams and an increase in the depth on the lower miter sill of Lock No. 1 to 6 feet at low water.

2. OPERATING AND CARE OF LOCK AND DAM NO. 2, MISSISSIPPI RIVER, BETWEEN ST. PAUL AND MINNEAPOLIS, MINN.

Lock and Dam No. 2 is the first of a series of two between St. Paul and Minneapolis, Minn., the object of which was to provide slackwater navigation over the stretch of river between Minnehaha Creek and the Washington Avenue Bridge, Minneapolis, Minn. No. 2 is the upper one of the series and was constructed first because navigation on the section above was difficult and hazardous under the most favorable conditions and virtually impossible at low stages of the river.

The river and harbor act approved June 25, 1910, modified the project for improving the Mississippi River between St. Paul and Minneapolis by providing for an increase in the proposed height of Lock and Dam No. 1. When the project is completed that lock and

Digitized by Google

dam will be sufficient for navigation purposes between the two cities, and Lock and Dam No. 2 will not then be needed. Lock and Dam No. 2 was completed in 1906, and its maintenance and operation have been provided for since July 1, 1907, by allotments from the appropriation for "Operating and care of canals and other works of navigation."

3. RESERVOIRS AT HEADWATERS OF MISSISSIPPI RIVER.

These are intended to improve navigable depths on the Mississippi River above Lake Pepin. Before improvement the river was subject to fluctuations of level between wide limits and was often unnavigable at low stages.

The project adopted in 1880 called for the construction of 41 reservoirs in Minnesota and Wisconsin to collect surplus water from the precipitation of winter, spring, and early summer and release it systematically during low water, so as to benefit navigation on the Mississippi River. The estimated cost, exclusive of land and flowage easements, was $1,809,083.

Under the project six reservoirs have been built, as follows:

Reservoir.	Capacity.	Original construction.		Reconstruction.	
		Completed.	Cost (approximate).	Completed.	Cost (approximate).
	Cubic feet.				
Winnibigoshish	43,992,000,000	1884	$230,000	1900	$154,200
Leech Lake	33,094,300,000	1884	95,000	1902	75,000
Pokegama	5,260,000,000	1884	115,000	1904	112,000
Sandy Lake	3,157,900,000	1895	122,000	1909	104,000
Pine River	7,732,900,000	1886	95,000	1907	118,500
Gull Lake	3,100,000,000	1913	77,200	.....	.....

Under act of Congress dated August 19, 1890, the sum of $150,000 was appropriated to be paid to the Chippewa Indians for flowage rights.

In addition to the above, surveys and flowage rights since 1898 cost $160,700.

4. OPERATING AND CARE OF RESERVOIRS AT HEADWATERS OF MISSISSIPPI RIVER.

Before 1894 the expenses of operation were paid from the appropriations for construction. By act of August 18, 1894, the "care, preservation, and maintenance" of the reservoirs were included under the appropriation for "Operating and care of canals and other works of navigation." Annual allotments have since been made from that appropriation.

The care, preservation, and maintenance of the reservoirs include repairs to dams, dikes, buildings, roads, telephone lines, etc., and the payment of salaries to dam tenders and gauge readers.

The reservoirs are operated mainly with a view to the improvement of navigation on the Mississippi River, but with due regard to other legitimate interests. Incidentally they are of great benefit in mitigating floods and in regulating the flow of water for power pur-

Digitized by Google

poses. No definite schedule can be determined beforehand, but the following are the general rules observed in operation:

(*a*) The discharge must not, by operation of the reservoirs, be reduced below the normal low-water flow of the streams affected. This rule is necessary in the interest of manufacturers.

(*b*) When logs arrive in the reservoir, they must be sluiced through. Transportation of logs by floating is a form of commerce and the main form of commerce on the streams affected by the reservoirs. It is dangerous to the dams to allow accumulations of logs, so that they must be sluiced through even in times of flood.

(*c*) The winter flow is so regulated as to make room for 39,000,000,000 cubic feet of water at the end of winter. This is the amount ordinarily to be expected in the spring floods.

(*d*) From the spring thaw until the dry season of summer (ordinarily until about July 10) as much water is retained in the reservoirs as possible, subject to rules (*a*) and (*b*).

(*e*) When the gauge at St. Paul has fallen nearly to 3 feet, water is released so as to keep the gauge at this reading. If there is not enough water for this purpose, then the greatest constant depth possible is maintained.

(*f*) When during the low-water stage there is not sufficient depth for the steamer plying between Aitkin and Grand Rapids and the quantity of water in the reservoirs is sufficient, enough water is released, on request, to make a trip possible. This use of the reservoirs is occasional.

As a result the river has been maintained during the summers of most years at a navigable stage in its upper portion and from St. Paul to Lake Pepin. Flood heights in the Mississippi have been reduced, often by several feet, and the benefit to manufacturing interests, due to the more uniform flow, has been great.

For capacities of reservoirs, maps of region, and comparison of rainfall and run-off, see Annual Report of the Chief of Engineers for 1896, page 1841, and for 1913, pages 2427–2428. For break in Pine River Reservoir, see Annual Report of the Chief of Engineers for 1896, page 1844, and for 1897, page 2144. For diagrams showing how much water had been stored each year in each reservoir, see Annual Report of the Chief of Engineers for 1900, page 2798. For report of Board of Engineers upon matters connected with the operation of the reservoirs, see Annual Report of the Chief of Engineers for 1906, page 1443.

6. MISSISSIPPI RIVER BETWEEN BRAINERD AND GRAND RAPIDS, MINN.

Work of snagging, bowlder removal, etc., was done under a project now expired for "Improving Mississippi River above the Falls of St. Anthony."

By the river and harbor act of June 13, 1902, this improvement was added to the project for "Reservoirs at headwaters of Mississippi River," and during the fiscal years 1902 to 1909, inclusive, was included in annual reports for that work. Under this project the sum of $19,000.96 was expended. As a result the channel between Brainerd and Grand Rapids was greatly improved by the removal of snags, bowlders, and overhanging trees.

Digitized by Google

8. MINNESOTA RIVER, MINN.

The original project, adopted in 1867, provided for the removal of snags and bowlders from the mouth to Yellow Medicine River, a distance of 237 miles. The original estimate of cost was $37,500, which was increased in 1869 to $52,500. Work was carried on systematically until 1879, and the project was practically completed by that time. In 1888 Congress appropriated $10,000 to be used in protecting the banks of the river at Belle Plaine, but that work was not done, and in 1892 authority was granted for the use of the money in building a low dam near the mouth of the river for the purpose of providing slack-water navigation to Shakopee, Fort Snelling Chute being made the main outlet of the river. The dam was built in 1893, and while it was of great assistance to navigation it occasioned complaints on account of high water. Congress, in 1902, authorized its removal in the discretion of the Secretary of War, and in 1908 it was taken out.

Above Le Sueur, 88 miles from the mouth, the act of Congress approved March 15, 1904, permits the erection of fixed bridges, with minimum clearances at ordinary low water, as follows: Horizontal, 40 feet; vertical, 20 feet, between Le Sueur and Mankato, and 15 feet between Mankato and Big Stone Lake.

9. RED RIVER OF THE NORTH, MINN. AND N. DAK.

The project for the Red River, adopted in 1876, provided for dredging and removal of obstructions from Breckenridge to the international boundary and the construction of a lock and dam to overcome the fall at Goose Rapids, the whole being with a view to obtaining channels as follows:

Breckenridge to Moorhead, 97 miles, a channel capable of being navigated during high and medium stages of water.

Moorhead to Grand Forks, 155 miles, a channel 50 feet wide and 3 feet deep at low water.

Grand Forks to the northern boundary line, 143.5 miles, a channel 60 feet wide and 4 feet deep at low water.

The estimated cost was $364,598.17. This project was modified, as follows: In 1883 the estimated cost was increased to $398,598.17. In 1887 the proposed lock and dam at Goose Rapids was dropped from the project and the estimate reduced to $252,598.37. In 1893 the estimate was increased to $310,320.

The improvement of Red Lake River was added to the project in 1896. It was proposed to provide a depth of 3 feet by dredging and removal of bowlders from Thief River Falls to the head of Red Lake. The amount authorized by Congress to be spent on this work was $9,000. The total estimate for both rivers was therefore $319,320.

10. WARROAD HARBOR AND WARROAD RIVER, MINN.

The river and harbor act of 1899, as amended by the act approved June 6, 1900, appropriated $3,000, or so much thereof as might be necessary, for improving the mouth of Warroad River, Minn. Nothing was done under this appropriation beyond making an examination and survey.

Digitized by Google

The original project was adopted in 1902, and provided for building a dredge and dredging in the harbor a channel sufficient for boats drawing 7 feet of water. The estimated cost was $45,000. This project was modified in 1905 so as to provide for a channel 100 feet wide and 7 feet deep from the inner end of the harbor channel to the boat landing at Warroad, with a turning basin for boats at the inner end, at an estimated cost of $35,000.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE KANSAS CITY, MO., DISTRICT.

---

1. MISSOURI RIVER.

The early appropriations were for the removal of obstructions and later for the improvement of selected localities. The acts continually changed the geographical limits of the divisions of the river. The first division of the river into sections was made by the river and harbor act of August 7, 1882, viz, mouth to Sioux City, Iowa (807.4 miles); Sioux City, Iowa, to Fort Benton, Mont. (1,477.4 miles).

In the river and harbor act of July 25, 1912, Congress formally recognized three divisions of the river, viz, (*a*) Kansas City to the mouth (392 miles); (*b*) Kansas City to Sioux City (415.4 miles); (*c*) Sioux City to Fort Benton (1,477.4 miles). The previous projects will be given separately for these divisions, and to complete the description a fourth section is added, (*d*) Fort Benton to Stubbs Ferry (179 miles).

(*a*) *Kansas City to the mouth.*—Government work on the river began as early as 1838, with the appropriation of $40,000 made by the act of July 2, 1836, for the Missouri jointly with the Mississippi River above the mouth of the Ohio River, to be expended for the removal of obstructions, and continued thereafter under annual appropriations, for the most part jointly for the Ohio, Mississippi, Missouri, and sometimes the Arkansas River, with occasional intermissions, until the act of June 18, 1878, made a separate appropriation for the Missouri.

The first improvement work done by the Government on this section of the river was under the river and harbor act of March 3, 1879, in accordance with the plans proposed in reports on the examinations of the river, as follows: At Kansas City, Mo. (S. Doc. No. 37, 45th Cong., 3d sess.); at Glasgow, Mo. (H. Doc. No. 46, 45th Cong., 3d sess.); at Cedar City, Mo. (H. Doc. No. 44, 45th Cong., 3d sess.). The plans proposed the protection of valuable property and the restoration of boat landings to their former facilities for river communication.

The act of June 14, 1880, included improvement work at Lexington and St. Charles under the above plans.

It is considered that Congress, by the act of August 7, 1882, adopted the original project for improving the river, "including such harbors on said river now in the course of improvement as in the judgment of the Chief of Engineers will benefit commerce and navigation."

Digitized by Google

The passage of this appropriation fairly inaugurated the thorough and systematic improvement of the Missouri River. The principles upon which the proposed work was based and the general plan to be followed were published as House Document No. 92, Forty-sixth Congress, third session, and republished in the Annual Report of the Chief of Engineers, 1881, page 1649. The ruling ideas were the protection of the concave bends from erosion by revetment, the rectification of channel by dikes "to such limits as would insure stability and regimen of appropriate uniformity of width and depth," and the removal of snags. The estimated cost of the work for this section was $3,750,000, with appropriate low-water width of 1,020 feet from Kansas City to mouth of the Gasconade River and 1,100 feet from mouth of Gasconade River to the Mississippi, and a minimum low-water channel depth of 6 feet. The Missouri River Commission was constituted by act of Congress July 5, 1884, and the same act provides for continuing the plan of improvement.

The river and harbor act of September 19, 1890, modified the original project and directed that, with certain specified exceptions, the appropriations should be expended by the Secretary of War "in systematic improvement of the river from its mouth up according to the plans and specifications of the Missouri River Commission, to be approved by him in reaches to be designated by them."

The effort of the commission was to accomplish a continuous, progressive control of the river, contracting it where necessary, giving the channel proper direction, and securely holding it in place. Work in this direction was done in the vicinity of Kansas City and on the first reach of the river, which extended from near Jefferson City to the mouth. On 45 miles of this stretch a continuous channel not less than 6 feet in depth at low water was obtained on what was originally one of the worst parts of the river, in the vicinity of the mouth of the Osage. In addition to forming a channel, much new land was formed and much land protected from destruction by the river. The greater part of the money appropriated for expenditure under the direction of the commission was not applicable to the comprehensive plan adopted, and about one-third was diverted to work at separate localities.

The Missouri River Commission was abolished by the river and harbor act of June 13, 1902. A condensed description of the works on the river executed under its supervision is given in the commission's last annual report. (Annual Report, Chief of Engineers, 1902, Supplement.) Since 1902 the works of the entire river have been consolidated under one district office.

Previous to the adoption of the present project the work on this section of the river was done under allotments and appropriations made from the general appropriations for the Missouri River, and consisted mainly of repairs to existing works and snagging. The amount expended on this section previous to the adoption of the present project was $7,224,056.11.

The river and harbor act of June 25, 1910, divided the river into two sections, viz, Kansas City to mouth and Kansas City to Fort Benton. The present project from Kansas City to the mouth was adopted July 25, 1912, though work has been carried on in accordance with this project since the passage of the act of June 25, 1910.

Digitized by Google

(*b*) *Kansas City to Sioux City.*—The river and harbor act of August 14, 1876, made the first departure from snagging on the Missouri River in providing for the expenditure of $40,000 for bank protection opposite St. Joseph, Mo., and at Nebraska City, Nebr., and Eastport, Iowa. The continuance of these projects was made possible by the act of June 18, 1878, which in addition authorized improvements at Fort Leavenworth, Kans.; Council Bluffs, Iowa; Omaha, Nebr.; and Sioux City, Iowa. Succeeding appropriations provided for these places and others and authorized local and extended surveys.

Following the act of August 2, 1882, which made a large appropriation for the work, the estimated cost of improving this section of the river was placed at $4,250,000, or about $10,000 per mile, on the supposition that the work would proceed regularly by reaches instead of in a disjointed and arbitrary manner. The contraction of the stream to be secured by such works contemplated low-water widths from 820 feet at Sioux City to 1,020 feet at the mouth of the Kansas River. The act itself provided for the expenditure of $850,000 in the improvement of the river from the mouth to Sioux City. Until it was adopted the localities demanding protection were each distinctly designated in appropriations. The method was attended by many disadvantages, since a separate plant was required for each locality, and the work had to be prosecuted in accordance with the terms of the act, although in some cases the general results might have been obtained at less cost and with greater benefit by the adoption of a more comprehensive and less restricted plan. Under this arrangement there was no continuity or relation between the different pieces of work, and navigation was helped but little. The small appropriations allotted to any one locality were insufficient to prosecute the work continuously to prompt and proper completion. As a result, an undue proportion of the funds was required for repairs to old work, since, uncompleted, it was an easy prey to the river. Usually the ultimate cost exceeded the amount of the first estimate, which was based on the supposition of continuous work; the aggregate amount of money expended was considerable, yet the results obtained were meagre and incommensurate with the cost.

Up to 1882 work was carried on in the vicinity of Kansas City, Leavenworth, Atchison, and Elwood, Kans.; Nebraska City, Plattsmouth, Omaha, and Covington, Nebr.; and Eastport, Council Bluffs, and Sioux City, Iowa. Obviously there could be no connection between these works. Under the plan for systematic and continuous improvement on a limited extent of river, most of these places were of necessity abandoned, but to prevent entire loss provision was made for continuing the incomplete work at Nebraska City, Omaha, and Sioux City, since the interests seemed important enough to justify this diversion of funds.

The Missouri River Commission, created in 1884, selected Kansas City as the initial point in the general improvement of the lower river, but it revetted the caving banks in Little Platte, Parkville, Quindaro, and Kaw Bends, the reaches immediately above Kansas City, as a preliminary to extending the work down the river. Beyond the activities just mentioned, nothing has been accomplished looking to a systematic improvement of this division of the river, and the appropriations as a rule have been applied with a view to protecting

Digitized by Google

city water fronts and training the current in the vicinity of bridges and improving the approaches thereto. In other localities, as at St. Joseph, where cut-offs have threatened the stability of the river, bank-protection works have been installed and maintained with satisfactory results. Local interests have accorded their cooperation in many instances. Since 1902 a snagboat has kept the channel free from snags by traversing the district one or more times each season.

The discontinuance in 1902 of the project from Sioux City to the mouth affected that part of the river above Kansas City but little. The work proceeded very much as before, as appropriations were always obtainable for localities where the need for improvement seemed urgent and the work advisable. During its existence the commission found itself unable to conserve all the appropriations for continuous progressive improvement below Kansas City; detached localities above that point continued to receive allotments for protection from time to time.

(*c*) *Sioux City to Fort Benton.*—None of the early allotments for snagging was spent above Sioux City, so that the first work accomplished was done in 1878, following the river and harbor act of August 14, 1876, which made available $20,000 for improvement above the mouth of the Yellowstone. Under this and succeeding appropriations local surveys were made and the channel improved at Dauphins Rapids, Cow Island, and other shoals. The work consisted of the removal of projecting rocks, reefs, and loose bowlders; dredging out the coarse gravel bars; and construction of solid dikes closing high-water chutes and secondary channels, and of wing dams to direct and concentrate the water at the bars. Thus a deeper channel was sluiced across shoals, while the pools created above the dams reduced the slope of the rapids.

These operations were conducted on the "Rocky River," as the 172-mile section between Carroll and Fort Benton came to be known through certain features which distinguished it from the rest of the river. It possessed a fixed regimen, stable banks, a bed composed of rock and gravel, carried little sediment, and was obstructed by few snags. The work necessary for its improvement was simple in character and lasting in its effects. Work could be carried on at detached places with the full expectation that all obstacles removed would result in permanent benefit to navigation.

The object sought in "Rocky River" improvement was a sufficiently deep and unobstructed waterway to accommodate the existing commerce, which at that time was heavy. Many boats of ordinary draft finding the obstacles insurmountable were forced to discharge their cargoes 125 miles or more below Fort Benton, the remainder of the route to Benton and destinations farther west being covered by teams with difficulty and at great cost. The improvements through 1883 had extended the navigable low-water depth 84 miles upstream, and by 1889 boats drawing less than 3½ feet could make their way to Fort Benton, except at the lowest stages. The aim had been to obtain a minimum low-water depth of at least 30 inches. The increase to be obtained through improvement was always less than a foot.

As the railroads penetrated the country, the commerce by river steadily decreased until it became so small that further work on this

Digitized by Google

portion of the river was deemed a needless expense, and, accordingly, operations were discontinued. The worst obstructions had already been removed and the shoals deepened as much as practicable. In later years a snag boat removed the obstructions in the channel at irregular intervals.

The so-called "Sandy River" is that part between Carroll and Sioux City. Its characteristics were muddy water, shifting sand bars, and an unstable channel, with easily and constantly eroding banks. The difficulties of navigation were due principally to sand bars, snags, and, to a lesser extent, loose rocks, and the width of the river was so great in places as to afford little available depth. No definite project for the entire division of the river has ever been adopted. However, early estimates placed the cost of complete rectification, including a contraction of the channel to a suitable width, at from $38,500 to $50,000 a mile, but it was recognized that the probable public benefit which might ensue was incommensurate with this expense. Snagging operations have been conducted over the entire stretch of river, but bank protection works have of necessity been confined to the localities of cities, towns, and steamboat landings where the maximum benefits to navigation might be expected to follow these improvements.

The first work accomplished was in the vicinity of Sioux City, Iowa, and Covington, Nebr., and at Vermilion, S. Dak., under the act of March 3, 1879. At Vermilion the banks were eroding rapidly, and a cut-off was imminent. Both banks near Sioux City were protected as the first step in a plan to rectify the reach and check inroads which threatened the safety of Covington and the existence of the Sioux City water front. Since 1880 bank-protection work, consisting of dikes and revetment, has been built at some period in the vicinity of nearly every river town of importance above Sioux City, including, among others, Elk Point, Vermilion, Yankton, Pierre, Fort Pierre, Bismarck, Mandan, Rockhaven, Washburn, Deapolis, Expansion, Williston, Judith, and Fort Benton.

Most of the early works were experimental and of cheap construction, and while they were often effectual, they rarely lasted more than one season as the ice or drift brought about their destruction. The development of the standard dike and revetment in use at the present time came after and through experiments and observations conducted through many years with various forms of artificial weeds, brush mattresses, willow curtains, tripod dikes, wire netting, and other inventions.

Besides those at Sioux City, the installations of most magnitude have been developed in the vicinities of Elk Point, Pierre, and Bismarck. The problem of the latter place involved complete rectification of the river, requiring the contraction of the channel to a suitable width. The works at Pierre aimed to restore the steamboat landing and direct the low-water flow along the town front by means of an extensive system of dikes and revetment along both banks. Over 1½ miles of revetment was built along the left bank near Elk Point to combat a tendency of the river to return to an ancient channel, thereby flanking the town. The works at other points have been mainly for the conservation of city water fronts and steamboat landings.

Digitized by Google

In 1891 snagging operations were commenced, and from one to three snag boats have been in commission every year since then, except when the funds were depleted. The value of their work has been very great. Wrecks due to snags were common in the early days of navigation, but are comparatively rare now.

Previous to 1884, and from 1890 to 1902, that portion above Sioux City was under a separate district office. From 1884 to 1890 it was under the supervision of the Missouri River Commission. Since 1902 it has been combined with the remainder of the river in one district. The division had been an artificial one, made simply for convenience of administration, there being no change in the character of the river for a long distance above and below Sioux City.

(*d*) *Fort Benton to Stubbs Ferry.*—As far as navigation is concerned the headwaters of the Missouri are completely and permanently separated from the river below. Between Fort Benton and Great Falls, 49 miles, the river has a descent of 695 feet, with three sheer falls of 90, 50, and 26 feet, and numerous rapids and smaller cascades. Navigation is impossible, and the section has never been regarded as susceptible of improvement. Between Great Falls and Stubbs Ferry, however, there have been possibilities of navigation, and attempts have been made to improve these, the first work being accomplished in 1881 under an appropriation for improving the river above the mouth of the Yellowstone. It consisted in the removal of rocks and the construction of wing dams at two of the worst rapids above Cascade, about $15,000 being thus expended. On the 76-mile reach between Stubbs Ferry and Cascade the average fall was 3.73 feet per mile, with depths less than 2.5 feet at a number of shoals. Bowlders, a constant succession of gravel shoals, and a narrow, sinuous channel in conjunction with a swift current, offered serious obstacles to prospective navigation. The work accomplished resulted in slightly increased depths at the improved places.

The original project, based on the survey of 1880 and submitted January 23, 1892, revived for a time the improvement above Fort Benton in providing for work on the "Long Pool," that 54-mile stretch of river between Cascade and Great Falls. With an average slope of 0.52 foot per mile, and navigable depths over the greater part of the distance, the opportunities for the limited operation of light-draft boats were, nevertheless, defeated by several shoals where the average low-water depth was less than 2 feet. The project proposed to obtain a channel 3 feet deep at low water from Great Falls to Cascade and 2.5 feet for the remaining distance to Stubbs Ferry. The cost was estimated at $115,837.50, but the revised project of November 30, 1894, increased the estimate to $165,812.50, and the revision of January 4, 1898, raised it still further to $213,646.50, the scope of the work being unchanged.

The river and harbor act of August 18, 1894, extended the upper limits of the river under improvement above Sioux City, from Fort Benton to Stubbs Ferry, thus enabling appropriations to be applied to the renewal of work above the falls. With the funds appropriated 19 closing and wing dams with an aggregate length of 9,481 feet were built during the period 1895–1898, and obstructions were removed from the channel. In this manner $65,933.73 was expended to June 30, 1899, in securing a 2.5-foot channel from Great Falls to

Digitized by Google

16 miles above, without producing a noticeable effect on commerce, partly due to the shortness of the improved waterway. Upon completion of this portion of the project, operations were suspended owing to lack of funds and the absence of incentive to further improvement. No appropriations for work above Great Falls were made after June 3, 1896. The commerce on this part of the river had always been small; in 1895 it was carried by two small passenger steamers.

The unexpended balance of $66.27 was turned into the Treasury June 30, 1899, and no appropriations were made thereafter for work above Fort Benton.

2. OSAGE RIVER, MO.

There were no adopted projects on the Osage River previous to the present projects. However, work was done by the State of Missouri, probably with some local cooperation, prior to 1870 and perhaps as early as 1854. The amount expended by the State of Missouri is said to have been $175,000. In a Government reconnoissance of the river in 1870 over 100 brush and stone wing dams were observed, the remains of early works, some of which are still to be seen in the lower 50 miles of the river. Where suitably located, these have been utilized as the foundation of more recent works.

4. GASCONADE RIVER, MO.

No project previous to the present project was adopted for the Gasconade River. Some wing dams and training walls were built by private interests before the United States took hold of the work.

An unusual condition was found at Pryors Chute. It is current report that in the early years a mill race about 3,000 feet long was cut by private interests across the neck on the right bank at Pryors Bend, for the operation of a mill near the foot of the bend. This race was enlarged by erosion and flanking at the mill, which necessitated a dam at the mill site, until finally the race was as large as the main channel. The fall was about 7 feet.

After the mill was abandoned, due to the excessive cost of maintaining the dam, an attempt was made by the Government to repair the dam, but the first rise destroyed the work. A training wall was later built across the head of the race or chute, as it is now called, but this was destroyed. Another dam has been built and its maintenance is a part of the work carried on under the present project.

5. KANSAS RIVER, KANS.

No project was adopted by Congress previous to the present project.

The first examination of the river by the Government was made in 1878, and the report, made February 5, 1879, is found on page 1089, Annual Report of the Chief of Engineers, 1879. The examination extended from Junction City to the mouth.

The river and harbor act of July 13, 1892, provided for another examination of the river. The district officer, as well as the Chief of Engineers, considered the examination in 1878 conclusive; therefore none was made in 1892. The report, however, dated February 9,

Digitized by Google

1893, contains the statement that the river was navigated in early days, but that in 1864 the State Legislature of Kansas declared the stream unnavigable. This law has not been sustained by the United States courts, but obstructing bridges have been built. The river was deemed not worthy of improvement by the Government.

The river suffered a severe flood in 1903, causing a damage of $20,000,000 at Kansas City alone. Another flood of smaller proportions followed in 1904 and another in 1908. A special report on flood conditions, encroachments, and bridges, was made in 1904 by a board of Engineer officers. (See S. Doc. No. 160, 58th Cong., 2d sess.) One important step in the prevention of flood damage, following this report of 1904, was the establishment of harbor lines by Congress in 1909, from the mouth to Argentine, a distance of about 5 miles, a survey for this purpose having been made in 1904.

HISTORICAL SUMMARY, GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE NASHVILLE, TENN., DISTRICT.

---

1. CUMBERLAND RIVER, TENN. AND KY.

(*a*) *Above Nashville.*—The first appropriation for the improvement of the Cumberland River above Nashville was by the river and harbor act of August 14, 1876, by which appropriation Congress adopted the first project for the improvement of this part of the Cumberland River. This project was based on the reports of January 20, 1871 (Annual Report for 1871, p. 468), and of February 8, 1872 (Annual Report for 1872, p. 463), for the 361½ miles of river from the mouth of Laurel River to Nashville, except for the 9 miles covered by the Smith Shoals reach; the project for which was based on the report of March 10, 1875. (Annual Report for 1875, p. 795.) The project for the river, except for the Smith Shoals, provided for the excavation of the bars and rock ledges to get additional depth of water; for the contraction of the waterway in places in order to obtain additional depth by this method; for the removal of snags and bowlders from the main channel, and for retaining tributary streams in well-determined channels at their junction with the main stream. For the Smith Shoals reach, which begins 25 miles below the mouth of Laurel River, the project provided for the excavation of rock to remove high places in the channel and for the construction of wing dams on both sides of the river for the purpose of contracting the waterway and thus deepening the channel so as to increase the aggregate period per year in which coal boats could pass downstream over the Smith Shoals and make such period of navigability for the shoals more nearly equal to the naturally longer navigable stage in the river below. The project estimate was $70,000 for the Smith Shoals reach, $6,600 for the portion of river above Smith Shoals, and $213,764 between Smith Shoals and Nashville, making a total project estimate of $290,364. The Smith Shoals estimate was

Digitized by Google

increased to $100,000 upon recommendation of the district officer in 1879. (Annual Report for 1879, p. 1267.)

The first two of the appropriations for the upper Cumberland River each designated that $2,000 of the money appropriated be applied between Smith Shoals and the Cumberland Falls, but no project was ever prepared for the 8.7 miles of river between the mouth of the Laurel and the foot of the falls, nor was any money ever expended on this short reach of river. The $4,000 appropriated was expended in the removal of large bowlders between Laurel River and Smith Shoals. Appropriations aggregating $282,000 were made and expended between the head of Smith Shoals and Nashville. The Smith Shoals project was regarded as completed, and sufficient benefit was effected to permit an increase in the traffic carried by rafts and coal barges passing downstream over the shoals. Between Smith Shoals and Nashville not all of the work originally contemplated was completed, but the improvements nevertheless resulted in a cleared channel for an increased depth through the principal obstructions and in an increased length for the season of navigation.

Above mouth of Jellico Creek.—The possible navigation on the Cumberland River is wholly interrupted by the Cumberland Falls, but there is a section above the falls of comparatively flat slope, for which Congress undertook the improvement by river and harbor act of March 3, 1881. The river between Pineville, Ky., 86 miles above the falls, and the mouth of Jellico Creek, 13 miles above the falls, was placed under a project of improvement based on a report dated November 17, 1880. (Annual Report for 1881, p. 1854.) This project provided for the removal of bowlders, snags, overhanging trees, etc., and for the modification of the numerous milldams which constituted the principal obstructions on this reach, subject to the securing of the consent of the owners of the dams. The total estimated cost was $55,000. In pursuance of the work under this project Congress appropriated $15,000, of which $10,000 was expended and $5,000 was subsequently transferred to the section between Nashville and the head of Smith Shoals. The work done was of practically no benefit, as none of the milldams were modified, and the improvement consisted merely in removal of bowlders, snags, and other obstructions of this character. The project for improving the river above the falls has been abandoned for many years.

The river and harbor act of July 5, 1884, appropriated $50,000 for improving Cumberland River above Nashville, in accordance with the plan proposed in the report of Maj. W. R. King, Corps of Engineers, dated February 26, 1884. (Annual Report for 1884, p. 1663.) This plan of improvement was for the construction of locks and dams, in order to provide for 5-foot navigation at low water from Nashville to the head of Smith Shoals, thus covering also the Smith Shoals reach, for which canalization had previously been recommended in Maj. King's report of February 15, 1882. (Annual Report for 1882, p. 1862.) It was proposed to construct 23 locks and dams between Nashville and Burnside at an estimated cost of $3,202,922, and seven locks and two dams in the Smith Shoals reach, at an estimated cost of $875,000, or a total of $4,077,922 for the improvement from Nashville to the head of Smith Shoals. The locks between Nashville and Burnside were to be about 60 feet wide and 250 feet

Digitized by Google

long between the miter sills. The Smith Shoals locks were to have chamber dimensions of 55 feet width and 145 feet length. The report of Maj. King stated that in some cases jetties would probably be more advantageous than locks and dams, and recommended that Congress specify the depth of navigable channel to be secured and that the Secretary of War be authorized to adopt the plan of improvement best adapted to the physical conditions of each section of the river. He stated that a depth of 4 feet at ordinary low water would probably be sufficient for all purposes of navigation.

The report of the Board of Engineers, dated March 30, 1887 (Annual Report for 1888, p. 1622), fixed the available dimensions of the locks at 52 feet width and 280 feet length, with lifts varying from 10 to 12 feet. In 1891 it was recommended that the project estimate for the construction of the 23 locks and dams between Nashville and Burnside be increased to $5,750,000 and that the Smith Shoals estimate be increased to $1,750,000 to provide for 7 locks and dams, or a total estimated cost of $7,500,000 for the canalization from Nashville to the head of Smith Shoals by 30 locks and dams. (Annual Report for 1891, p. 2270.) The report of the Board of Engineers, dated November 25, 1890 (not printed but referred to in Annual Report for 1892, p. 1933), fixed the minimum depths on the miter sills of the locks at 6½ feet and the low-water navigable depth to be obtained at 6 feet. Under the approval of the Chief of Engineers, dated August 12, 1895, the number of locks and dams in the Smith Shoals reach was reduced to six, no change being made in the project estimate. (Annual Report for 1896, p. 1915.) One of the 23 locks and dams proposed between Nashville and Burnside was also omitted, but the date and authority for this modification can not be ascertained. This modification was first referred to in 1905, when it was stated that the plan of improvement included the construction of 22 locks and dams below Burnside. (Annual Report for 1905, p. 451.) Upon recommendation of the district officer in 1896, the estimated cost of canalizing the river from Nashville to the head of Smith Shoals was increased to $8,500,000 (stated erroneously as $9,000,000 in Annual Report for 1896, p. 1916, but corrected in Annual Report for 1897, p. 2224).

Thus the several modifications in plan and estimate for the canalization between Nashville and the head of Smith Shoals resulted in a plan for the construction of 28 locks and dams, at a total estimated cost of $8,500,000. It is under this project, as modified, that the existing locks and dams have been constructed, but the project itself has been modified by the elimination of the construction of locks and dams between Nos. 7 and 21 and of the 7 locks and dams proposed above the existing Lock and Dam No. 21.

The first appropriation under the canalization project, amounting to $50,000, was expended in open-channel work, with a view to ascertaining how far wing dams and training walls could be used in combination with locks and dams for the purpose of improvement, but after this expenditure was made the contraction method of improvement was discontinued. Since this expenditure was not applied to canalization, it has not been charged to the present canalization project, but is considered as an expenditure under a previous project. In the Smith Shoals reach the river was surveyed from Burnside to

Digitized by Google

Rockcastle River, detailed surveys being made for the lock sites and abstracts of title being prepared for the lands necessary. The amount expended for these purposes was $20,252.94, but no appropriation has ever been made by Congress for the actual construction of the locks and dams proposed in this reach. This expenditure, also, has been charged to previous projects in view of the fact that the project for the Smith Shoals reach has been abandoned.

The river and harbor act of March 3, 1905, authorized the Cumberland River Improvement Co. of Kentucky to improve the Cumberland River and tributaries, including the South Fork, above the town of Burnside, Ky., at its own expense, but under Government supervision, by the construction of locks and dams equal in size and capacity to existing locks and dams on the Cumberland River, the corporation being granted the use of the water power thus developed. The franchise granted by this act lapsed because of the failure of the corporation to begin work within 18 months after the completion of Lock and Dam No. 21, as required by the act.

The total amount expended on the Cumberland River above Nashville on old projects of improvement amounted to $366,252.94, which represents the aggregate of the expenditures mentioned under the different projects described above.

(*b*) *Below Nashville.*—From July 17, 1832, to July 7, 1838, Congress made five appropriations for improving the Cumberland River, Tenn. and Ky., aggregating $155,000, $20,000 of which was to be expended below Nashville and $135,000 on the river generally, but all the appropriations for the above period were expended below Nashville to improve the worst localities.

Between 1838 and 1871 no appropriations for this river were made. The original project (open-channel work), which provided specifically for operations on this section, was adopted by the river and harbor act of March 3, 1871, based on project submitted January 20, 1871. (Annual Report for 1871, p. 468.) The work proposed was as follows: To excavate the bars and rock ledges, in order to get an additional depth of water; to contract the waterways in places, in order to get the requisite depth; to remove snags and bowlders from the main channel; and to restrain tributary streams in well-determined channels at their junction with the river. The estimated cost was $248,821.

To increase the depth of water at the shoals in Kentucky Chute, at the junction of the Cumberland with the Ohio River, a board of engineer officers in 1888 recommended the construction of a dike near Smithland, Ky., at an estimated cost of $129,600. (Annual Report for 1888, p. 1626.) The river and harbor act of September 19, 1890, allotted $30,000 from the appropriation for improving Cumberland River below Nashville, to be expended in improving the mouth of the river, as recommended.

Appropriations aggregating $305,000 were made and expended, thus completing the above project. The expenditures under the old project have resulted in lengthening the season of navigation by giving an increased depth at low water, combined with greater security in the passage of obstructions.

Digitized by Google

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE CHATTANOOGA, TENN., DISTRICT.

1. TENNESSEE RIVER, TENN., ALA. AND KY.

In making appropriations Congress formerly recognized three divisions of this stream, viz, (*a*) above Chattanooga, Tenn. (188 miles); (*b*) Chattanooga, Tenn., to Riverton, Ala. (237.6 miles); (*c*) below Riverton, Ala. (226.5 miles). The previous projects will be given separately for these divisions.

(*a*) ABOVE CHATTANOOGA.

The river and harbor act of August 30, 1852, appropriated $50,000 for improving the Tennessee River "in conformity with the estimates of the War Department of July 13, 1852." This project was for the portion of the river between Knoxville and Kellys Ferry (22.4 miles below Chattanooga) and contemplated securing a depth of 2 feet at extreme low water over all bars in this reach of the river by contraction works and by the excavation of a small amount of rock and gravel, and the removal of loose rocks, logs, snags, etc.; and provided for supplying the necessary aids for "warping" the boats through swift water.

It is considered that Congress, by the river and harbor act of June 10, 1872, adopted as the next, or second, project for improvement of the river above Chattanooga the plans proposed in the reports of the examinations of the river between Kingston and Chattanooga (Annual Report for 1871, p. 502), and between Knoxville and Kingston (H. Ex. Doc. No. 76, 42d Cong., 2d sess.). This project provided for securing a channel 3 feet deep and 140 feet wide at extreme low water over all of the shoals between Knoxville and Chattanooga (183.5 miles) by the removal of sand, gravel, snags, isolated rocks and bowlders, and a small amount of solid rock, and by the construction of contraction works. The estimated cost of the work between Knoxville and Kingston was $125,000, no cost being given for the remaining portion of the river. In 1874 the cost of the whole improvement was estimated at $175,000, based on the quantities given in the project reports. (Annual Report for 1874, p. 572.) This estimate was increased in 1877 to $225,000 (Annual Report for 1877, p. 579); in 1884 to $300,000 (Annual Report for 1884, p. 251); and, finally, in 1891 to $340,000 (Annual Report for 1891, p. 2255). The amount expended on this project was $328,255.83. Though the project provided for 3-foot depth, this depth was rarely obtained by the work done.

Congress by river and harbor act of August 18, 1894, adopted the third and last of the previous projects for the Tennessee River above Chattanooga, as submitted in the report of the survey ordered by act of September 19, 1890. (H. Ex. Doc. No. 252, 52d Cong., 2d sess.) This project applied to the section of the river between Chattanooga and the junction of the Holston and French Broad Rivers. The plan of improvement was the same as that under the preceding project. The object was to improve the river to the best advantage without

Digitized by Google

attempting to obtain the full 3-foot depth at first, except where blasting was required. The estimated cost of the improvement was $650,000. A revised estimate, made June 1, 1907, and approved June 12, 1907, placed the cost of completing the improvement at $1,080,000, in addition to the $629,000 previously appropriated for this and the preceding project. The amount expended on this project was [1] $481,593.19.

The work done under previous projects improved some of the worst shoals and cleared the channel of surface obstructions so as to make navigation possible except at low stages.

(*b*) CHATTANOOGA TO RIVERTON.

Open-channel work.—The first project adopted by Congress for any improvement in this section was that adopted by the river and harbor act of August 30, 1852, for the portion of the river between Knoxville and Kellys Ferry, which included the first 22.4 miles of the section below Chattanooga. For description of this project see under previous projects for above Chattanooga.

It is considered that by the river and harbor act of July 25, 1868, Congress adopted as the next or second project for the improvements in the section of the river between Chattanooga and Riverton the plans proposed in the report of the survey of the river between Chattanooga and the mouth (H. Ex. Doc. No. 271, 40th Cong., 2d sess.) as far as they related to open-channel work. This project contemplated securing a channel 3 feet deep at low water between Chattanooga and Decatur and between Florence and the mouth by channel excavation, by contraction works, and by the removal of isolated obstructions, at an estimated cost of $90,000 for the reach between Chattanooga and Decatur, and $40,000 for that between Florence and the mouth. Apparently the width contemplated was 100 feet. The amount expended under this project was [2] $583,461.21.

By the river and harbor act of March 2, 1907, Congress adopted as the third and last of the previous projects for improvement by open-channel work in this section the plans proposed in the report of the survey ordered by act of March 3, 1899, from Scott Point to Lock A. (H. Doc. No. 50, 57th Cong., 1st sess.) This project contemplated securing a channel 5 feet deep at low water for a width suitable for navigation over the reach of the river between the Hales Bar Lock and Lock A by contraction works, bank protection, channel excavation, and the removal of snags and similar obstructions. The estimated cost of the improvement, as given in the report, was $770,640; but a revised estimate of June 1, 1907, based on increased unit prices, placed the cost of the work remaining to be done at that time at $1,231,500. The river and harbor act of June 25, 1910, adopted the report of the Board of Engineers, dated February 1, 1909 (Rivers and Harbors Com. Doc. No. 12, 61st Cong., 2d sess.), thus modifying this project so as to include the improvement of the reach of the river between the Florence bridge and the head of Col-

[1] Includes the expenditure of $170 received from sales.
[2] Corrected by an amount of $12,043.32 expended below Riverton (Annual Report for 1891 p. 2257) and previously reported in error as expended between Chattanooga and Riverton and exclusive of reimbursements amounting to $28.21 included in the expenditures given in previous reports but inclusive of the expenditure of $906.87 received from sales.

Digitized by Google

bert Shoals, at an estimated cost of $250,000, making a total of $1,481,500 as the revised estimate for the improvement of all of the river between Chattanooga and Riverton, with the exception of the portion between Lock A and the Florence bridge, and the portions under improvement by the Hales Bar Lock and Dam and the Colbert Shoals Canal. The width of channel to be obtained in the Florence to Colbert Shoals section was stated to be 150 feet. The total amount expended under this project was $417,662.70.[1]

The work done under the previous projects for open-channel work improved some of the worst localities and cleared the channel of surface obstructions so as to make navigation possible except at low stages.

Muscle Shoals improvement.—It is considered that Congress, by the river and harbor act of March 3, 1871, adopted as the project for the improvement of these shoals the plans proposed in the report of the survey of the river between Chattanooga and the mouth (H. Ex. Doc. No. 271, 40th Cong., 2d sess.), in so far as it related to this part of the river. This report provided for a canal in three divisions on the north side of the river, each 100 feet wide and 6 feet deep, with locks 300 feet between miter sills and 70 feet wide. The first division was to be about 11 miles long and have five locks to surmount Elk River Shoals. The estimated cost of this work was $2,463,089.95, which the district officer believed should be increased by 15 per cent. A dam across the river about a mile below Browns Ferry was suggested as a means of reducing the above estimate by about 50 per cent, but data was not at hand to make an estimate on this basis.

The second division of the canal was to be obtained by enlarging to the required dimensions the existing canal around Big Muscle Shoals, which had been abandoned and had fallen into decay and disintegration. The canal was completed by the State of Alabama in 1836, and when completed had a width of from 60 to 70 feet and a depth of 6 feet, with 17 locks 32 feet wide and 120 feet between the miter sills and average lifts of 5 feet. The district officer increased the estimated cost of reconstructing this canal to $1,500,000.

The third division of the canal was to be about 4½ miles long and surmount the Little Muscle Shoals. The cost was approximately estimated at $500,000.

Though not specifically stated in any subsequent acts, it has been considered that the following modifications of this project had the approval of Congress. The report of the survey between Browns Ferry and Florence (Annual Report for 1872, p. 495), ordered by act of March 3, 1871, proposed the first modified plan. This plan also provided for a canal in three divisions, as before, and, in addition, included three dams across the river—one below Browns Ferry, one below Elk River Shoals, and one below Campbells Ferry. The canals were to be 100 feet wide and 6 feet deep, and the locks 300 feet long between miter sills and 60 feet wide. The Elk River Shoals division was to have 9 miles of canal trunk, with 3 locks and 2 guard locks, and 2 crib dams across the river, at an estimated cost of $1,115,000. The Big Muscle Shoals division was to have a new guard lock, 15 miles of canal trunk were to be widened, dams and culverts constructed, and the 17 old locks rebuilt, at a total estimated cost of $1,465,000. The

[1] Includes the expenditure of $56.63 received from sales.

Digitized by Google

Little Muscle Shoals division was to have 6½ miles of canal trunk, 3 lift locks and 2 guard locks, and a crib dam across the river, at an estimated cost of $902,500; making the total estimate for the three divisions, after allowing for contingencies, $3,676,000. This estimate was increased by later surveys to $4,003,000.

The report of the survey from the head of Browns Island to Lambs Ferry (Annual Report for 1877, pp. 579 and 590), proposed a modified project for the improvement of Elk River Shoals by the construction of a canal along the south bank of the river. This canal was to have three locks—one near each end of Gilchrist Island and one about a mile above the head of the island. A dam was to connect the head of Gilchrist Island with the foot of Browns Island so as to form a canal. These works were to be supplemented by channel excavation and the construction of riprap dams. A channel 100 feet wide was also to be excavated through Nances Reef below the lower lock. It was estimated that these improvements could be made for $736,249, or $378,750 less than the lowest estimate for the canal on the north side of the river. The district officer in his report (Annual Report for 1877, p. 582) proposed to reduce the number of locks in the Big Muscle Shoals division to 10, and the number was finally reduced to 9 (Annual Report for 1879, p. 1250). The district officer also proposed (Annual Report for 1877, p. 583) to improve the Little Muscle Shoals division by channel excavation and contraction works on the north side of the river, so as to give "as great depth of water on them as can be obtained throughout a considerable portion of the river, both above and below Muscle Shoals." It was decided later to omit the lock proposed at the foot of Gilchrist Island and to excavate a canal prism on the shore between the other two locks and build the retaining dam from the foot of Browns Island to the upper lock. This was the final modification of any consequence.

The project, as finally modified, was reported as practically completed in 1890. The total cost of the improvement was $3,191,726.50. A satisfactory depth was not obtained, however, in the portions of the project section that were improved by open-channel work, and an extreme low-water depth of 1 foot is found in the reach above Lock A.

(*c*) BELOW RIVERTON.

The first project which provided for any improvement of the Tennessee River below Riverton was included in a project which is considered to have been adopted by the river and harbor act of July 25, 1868. For details of this project, see description of second previous project for the open-channel work in the section between Chattanooga and Riverton. Under this project $12,043.32[1] was expended below Riverton. (Annual Report for 1891, p. 2257.)

The second and last previous project for this section of the river is considered to have been adopted by the river and harbor act of September 19, 1890, which authorized the protection of Livingston Point, at the mouth of the river, according to the recommendation of the officer in charge. (H. Ex. Doc. No. 172, 51st Cong., 1st sess.) The plan adopted was the revetment of the banks with stone and brush

[1] This amount has previously been included in the expenditures between Chattanooga and Riverton.

Digitized by Google

and the construction of a pile-and-stone dike along the crest of the weakest point, where the Ohio cuts through at high stages, at an estimated cost of $180,000. The river and harbor act of August 18, 1894, extended this project in scope, so as to provide for the removal of snags and other obstructions to navigation below Riverton, and also authorized a survey of this portion of the river to be made. The maps of this survey were completed in 1897, but no detailed report was ever made. An estimate made in 1898, and based on this survey, showed that 90,385 cubic yards of rock and 563,434 cubic yards of gravel were to be removed to obtain a channel 150 feet wide and 5 feet deep at low water. (Annual Report for 1901, p. 2439.) The Annual Report of the Chief of Engineers for 1901, page 466, states that the project is to obtain by dredging a low-water channel not less than 5 feet deep and 150 feet wide. The amount expended on this project was $534,051.92.[1] Under this project Livingston Point was protected, and many of the shoals were improved by dredging.

2. FRENCH BROAD RIVER, N. C. AND TENN.

An examination of the French Broad River, N. C., from Brevard to the Buncombe (Henderson-Buncombe) County line, was made in 1874 and 1875 under authority of the river and harbor act of June 23, 1874. (Annual Report for 1875, p. 817.) The examination of the French Broad River was continued in 1875 from the Henderson-Buncombe County line to its junction with the Holston under authority of the river and harbor act of March 3, 1875. (Annual Report for 1876, p. 718.) In order to obtain sufficient information to form definite plans for the expenditure of the $10,000 appropriated by the river and harbor act of August 14, 1876, the river was surveyed in 1877 from Brevard to the head of Big Buck Shoals, about 30 miles. (Annual Report for 1878, p. 525.) For the same reason a survey was made from Smiths Bridge, at Asheville, to the foot of Long Shoals, about 12 miles above Smiths Bridge and 4½ miles below the head of Big Buck Shoals, on which to base a plan for the expenditure of the $5,000 appropriated by the river and harbor act of August 2, 1882, for "continuing improvement from Smiths Bridge up." (Annual Report for 1883, p. 832.) The report of the survey from Brevard to Big Buck Shoals contained three plans for the improvement of this reach—(1) by locks and dams, (2) by lateral dams, (3) by short wing dams and groins—each of which was to be supplemented by channel excavation. The third method was adopted as being best adapted to the river and least expensive. This project contemplated securing a channel 34 feet wide and 2½ feet deep at low water, at an estimated cost of $45,500. The estimated cost of improving the reach of the river from Smiths Bridge to the foot of Long Shoals, by the methods adopted for the section between Brevard and Big Buck Shoals, was $76,000 for a channel 35 feet wide and 2¼ feet deep, making the total estimated cost of all the improvements proposed in North Carolina $121,500. From 1876 to 1882 appropriations were made aggregating $43,000, and this sum was applied towards carrying out the project for the improvement of the sections of the river from Brevard to the head of Big Buck Shoals and be-

[1] Includes $572.96 received from sales and $276.93 received as damages to dredges.

Digitized by Google

tween the foot of Long Shoals and Asheville. The $38,000 appropriated for the section above Big Buck Shoals was expended in improving about 26 miles of this reach, where a channel 2½ feet deep and 35 to 40 feet wide was obtained, while the $5,000 appropriated for "above Smiths Bridge" was expended in improving the first 4½ miles of the river above Asheville, the channel dimensions obtained not being definitely stated. The work done gave somewhat improved conditions for navigation, but little, if any, use was made of the improvement, and the work has been abandoned since 1885.

3. HIWASSEE RIVER, GA., N. C., AND TENN.

A project for improving the Hiwassee River from its mouth to Savannah Ford (41.6 miles) was adopted by the river and harbor act of August 14, 1876, based on report of an examination dated October 19, 1874. (Annual Report for 1875, p. 809.) This project contemplated securing a channel 40 feet wide and 2 feet deep at low water by the excavation of rock reefs and gravel bars, the construction of riprap dams, and the removal of snags and other surface obstructions, at a total estimated cost of $20,000. This estimate was increased to $30,000 in 1878 (Annual Report for 1878, p. 762), followed by a further increase of $4,000 in 1882 (Annual Report for 1882, p. 1848), and was finally increased to $36,500 in 1885 (Annual Report for 1885, p. 1764). The work done under this project consisted in the removal of a large number of snags and overhanging trees, the excavation of about 3,000 cubic yards of reefs and bowlders, and the construction of numerous dams, estimated to contain 7,500 cubic yards of riprap stone. The work done was mainly below Charleston, Tenn., 18.9 miles above the mouth, and resulted in a partial improvement of the river at 14 different localities, securing an increased depth of channel and a consequent lengthening of the season of navigation. The amount appropriated under this project was $36,500, of which $36,427.07 was expended and $72.93 transferred to the present project.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF THE OHIO RIVER BY CONSTRUCTION OF LOCKS AND DAMS.

In 1820 Congress made an appropriation for a survey of the Ohio River from Louisville to the Mississippi River and down that river to its mouth. This survey was made in 1821 by Capts. Young and Poussin, of the Topographical Engineers, and Lieut. Tuttle, of the Engineers. In 1824 an appropriation of $75,000 was made for the improvement of certain sand bars in the Ohio and for the removal of snags from the Ohio and Mississippi Rivers. During the following year, Maj. S. H. Long, Topographical Engineers, began the construction of the first dike on the Ohio at Henderson, Ky.

Under a charter granted by the State of Kentucky in 1825 a stock company constructed the Louisville & Portland Canal around the falls of the Ohio, which was opened for traffic in 1830. The United States was one of the original stockholders in this company and gradually increased its holdings until on February 8, 1855, all stock was owned by the United States except five shares held by the direc-

Digitized by Google

tors to qualify them to hold such office. These directors continued to manage the canal until the United States assumed control on June 11, 1874, purchasing the remaining five shares of stock. Between 1868 and 1873 the United States, although not managing the canal, made a series of appropriations for increasing its navigable capacity. Appropriations made since 1874 have been applied to its further improvement.

In 1830 work was begun on the removal of rocks at Grand Chain, and dikes at Scuffletown, Sisters, and French and Cumberland Islands were constructed in 1831 and 1832. The first permanent work above the falls was the dam at Browns Island, constructed in 1836. The construction of dikes and cut-off dams was in pursuance of the project of regulation of depths by closing island chutes and by narrowing the channel by dikes projecting from the bank, in order to concentrate the water upon bars to cause their removal. This method of improvement was carried on at many places until the practical discontinuance of appropriations for the Ohio in 1844. From 1826 to 1844 appropriations were made for the improvement of the Ohio with approximate regularity, but from 1845 to 1866 only two appropriations were made, one of which was quite small and the other only $95,000. Upon the resumption of appropriations in 1866 the method of improvement by works of contraction was resumed, together with the removal of snags, wrecks, and other obstructions and the cutting of channels by dredging through bars not regulated. Ice harbors have also been constructed at various points above the falls.

While the method of improving the navigable channel of the river by means of dikes and cut-off dams was believed to be successful for the purpose of maintaining a minimum navigable depth of 3 feet, it was recognized at an early date that to provide for the accommodation of coal fleets the best method of improving the river, at least in the upper part of its course, was by means of locks and dams. The first recorded proposition for this purpose was made by Mr. W. Milnor Roberts, civil engineer, in 1870. In April, 1872, a board of engineers was appointed to examine and report upon the applicability of certain plans for movable hydraulic gates for chutes and locks. In 1874 Maj. W. E. Merrill, Corps of Engineers, recommended the construction of 13 locks and movable dams with Chanoine wickets between Pittsburgh and Wheeling, and stated that there is no doubt of the absolute necessity of using locks in any rational plan for improving the upper Ohio so as to secure a 6-foot navigation. In 1875 Maj. Merrill expressed himself in favor of extending the movable-dam system throughout the entire river, qualifying his statement as to its applicability below the falls of the Ohio by saying that, although not assured of its serviceability there, it was a better system than one of permanent dams and the only other system promising 6 or 7 feet of navigation at low water, the system of dikes not being likely to afford more than 4 feet at extreme low water, and then only after an immense development of such works. The river and harbor act of March 3, 1875, appropriated $100,000 "to be used for and applied toward the construction of a movable dam, or a dam with adjustable gates, for the purpose of testing substantially the best method of improving, permanently, the navigation

Digitized by Google

of the Ohio River and its tributaries." This dam was constructed at Davis Island.

The river and harbor act of August 11, 1888, directed the appointment of a board of three Engineer officers, whose duty it was to examine and report as to the feasibility and advisability of improving the Ohio River below Pittsburgh by means of movable dams. This board recommended the construction of four dams below Davis Island, it being proposed to locate the lowermost one, No. 5, just below the mouth of the Beaver River. As constructed, however, No. 5 is located just above the mouth of the Beaver River. The river and harbor act of September 19, 1890, provided funds for the construction of a dam at or below the mouth of the Beaver River, Pa., "at such locality as the Secretary of War may consider most advantageous." This dam, No. 6, is located at a point 3.7 miles below the mouth of Beaver River. The initial appropriation for construction of Locks and Dams Nos. 2, 3, 4, and 5 was made by river and harbor act of June 3, 1896. The river and harbor act of July 18, 1892, provided funds for purchase of site for Dam No. 2.

The river and harbor act of June 3, 1896, authorizing a survey of the Ohio River from Pittsburgh to Marietta, called for a report on "the number of movable dams necessary to improve said river between said points to provide 6 feet of water therein at low water and the probable location of the necessary dams, as well as the probable cost thereof." This report (H. Doc. No. 122, 55th Cong., 3d sess.) provided for a system of 18 locks between the points named, and appropriations were made by river and harbor acts as follows for beginning the construction of the locks and dams (Dams Nos. 1 to 6 having already been provided for, as shown above): Dams Nos. 13 and 18, March 3, 1899; Dams Nos. 7, 8, 11, and 19, June 13, 1902. Only the sum of $23,000 was appropriated by the act of June 13, 1902, for Dam No. 7, and this amount was expended in acquisition of site, preparation of plans, etc., no work of construction being undertaken until additional funds were provided by the river and harbor act of June 25, 1910.

The river and harbor act of March 3, 1899, providing for a survey of the Ohio River between Marietta, Ohio, and the mouth of the Big Miami, states that the survey is to be made "with a view to the improvement of said river between said points by movable dams and otherwise so as to provide 6 feet of water in said river at low water, this survey to include a report upon the location of the necessary dams and the probable cost thereof." As this was in continuation of the previously authorized project, the locks were given consecutive numberings. Appropriations for their construction were made by river and harbor acts as follows: Dam No. 26, March 3, 1905; Dam No. 37, June 13, 1902. Dam No. 37 corresponds with the lock to be located near Cullums Ripple, referred to in the joint resolution of January 10, 1899. (See H. Doc. No. 265, 55th Cong., 3d sess.)

The river and harbor act of June 13, 1902, provided for an examination at and below pool No. 1 in said river with a view of securing increased depth and additional harbor facilities for the city of Pittsburgh. A board of officers of the Corps of Engineers ordered to consider and report upon this matter was of the opinion that to

Digitized by Google

meet the demands of traffic a depth of 9 feet should be provided from Davis Island (Lock No. 1) to Lock No. 7. (Annual Report for 1903, p. 1693.) The river and harbor act of March 3, 1905, appropriated funds for securing a stage of 9 feet in the pools made by Dams Nos. 2, 3, 4, 5, and 6 by a modification of those locks and dams. Further appropriations for this purpose were made by sundry civil act of June 30, 1906, and river and harbor act of March 2, 1907.

The river and harbor act approved March 2, 1907, directed that Dams Nos. 11, 13, 18, 26, and 37 be so constructed as to provide a navigable depth of 9 instead of 6 feet. Increased depth at No. 19 was not authorized prior to June 25, 1910, when the general project for complete canalization of the river with a view to 9-foot navigation was adopted.

With the exception of No. 19, the locks and dams authorized prior to the adoption of the general project in 1910 have been completed, and were placed under operating and care as follows:

Dam No.	Date.	Dam No.	Date.	Dam No.	Date.
1	Oct. 7, 1885	5	Nov. 21, 1907	13	Aug. 1, 1911
2	Oct. 13, 1906	6	Aug. 17, 1904	18	May 1, 1910
3	Feb. 1, 1908	8	July 14, 1911	26	Aug. 1, 1912
4	do	11	Aug. 1, 1911	37	Jan. 1, 1911

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECT FOR IMPROVEMENT OF RIVER IN PITTSBURGH, PA., DISTRICT.

MONONGAHELA RIVER, W. VA. AND PA.

The project for the construction of Locks and Dams Nos. 8 and 9 was adopted February 5, 1872. This project was completed on November 8, 1889, with the result that boats drawing 5.2 feet of water could navigate the river in low water as far upstream as Morgantown, W. Va., the river having been previously slack-watered from its mouth to Lock No. 8 by the Monongahela Navigation Co. The amount expended under this project was $436,900.

A provision of the river and harbor act of June 3, 1896, authorized and directed the Secretary of War to institute and carry to completion proceedings for condemnation of all the property and appurtenances of the Monongahela Navigation Co. The property was acquired by the United States on July 7, 1897, and includes Locks and Dams Nos. 1 to 7, inclusive. The total amount expended was $3,769,073.88.

The act of March 13, 1897, provided for the construction of six locks and dams, Nos. 10 to 15, inclusive, between Morgantown and Fairmont. The completion of this project in 1904 extended slack-water navigation of the Monongahela River, 28 miles, from Morgantown to 4 miles above Fairmont, W. Va., with a minimum navigable depth of 7 feet. The locks have single chambers, 56 feet by 182 feet. The amount expended is $1,322,793.80.

During the years 1883 and 1884 a concerted movement was inaugurated by the coal operators and dealers in Pittsburgh and elsewhere along the Ohio favoring the purchase of the locks and dams of the Monongahela Navigation Co. by the United States and making them

Digitized by Google

free of tolls. It was argued, apparently with much reason, that, as the Government was then engaged in improving the Kanawha River in West Virginia, by means of a system of locks and dams which would enable the West Virginia coal from the Kanawha Valley to reach the Ohio free of tolls at a point 261 miles nearer the markets of the West and South than the mouth of the Monongahela, the Pittsburgh operators would experience great difficulty in competing in the future with the West Virginians, hampered as the former were with a toll charge on coal amounting, upon an average, to 6½ cents per ton.

The river and harbor act of August 5, 1886, authorized the Secretary of War to appoint a board of three competent engineers from the Engineer Corps, United States Army, to ascertain the value and commercial importance of the works and property of that company in Pennsylvania.

The report of the board of engineers (H. Ex. Doc. No. 112, 49th Cong., 2d sess., and republished in H. Ex. Doc. No. 249, 43d Cong., 3d sess.) expressed the opinion that the commercial importance of the Monongahela was very great and fixed the value of the tangible property of the company at $1,950,000.

The river and harbor act of August 11, 1888, provided for the amicable purchase of Lock and Dam No. 7, at a cost not to exceed $161,733.13 and further provided that in the event of the inability to make voluntary purchase, authorized the Secretary of War to institute proceedings for the condemnation of the lock and dam.

Upon the refusal of the company to sell, condemnation proceedings were instituted. The case was heard before a board of viewers appointed by the Circuit Court of the United States for the Western District of Pennsylvania. The value of the work in question was fixed by the board at $209,393.52, without reference to the value of the franchise. Exception to this verdict was filed by both parties, and in November, 1890, the case came up for a final hearing and the verdict reached was for $209,000.

The act of Congress provided that either party might appeal to the United States Supreme Court. The navigation company appealed the case to that court, which rendered an opinion, given in No. 722, October term, 1892, reversing the judgment and granting a new trial.

The river and harbor act of September 19, 1890, provided for condemnation of Lock and Dam No. 6, and appropriated $162,000 for this purpose, stipulating that the title to Lock and Dam No. 7 must first be secured to the Government before proceedings could be instituted for the purchase and condemnation of Lock and Dam No. 6.

Nothing further was done until the river and harbor act of August 17, 1894, authorized the Secretary of War to investigate and report the sum of money necessary to acquire all the locks and dams, the property of the navigation company, and to take testimony as to the value of said improvement and the commercial usefulness of said river, to the end that Congress might determine as to the expediency of making said river free of tolls.

Upon the recommendation of the Chief of Engineers the Secretary of War designated Maj. R. L. Hoxie, Corps of Engineers, to receive testimony regarding the value of the property of the Monongahela Navigation Co. The report of the Chief of Engineers, embracing

Digitized by Google

the report of Maj. Hoxie, was submitted to the Secretary of War December 12, 1895 (printed as H. Doc. No. 78, 54th Cong., 1st sess.). In his report Maj. Hoxie expressed his opinion that the least valuation through the process of condemnation of the property and franchise of the Monongahela Navigation Co. be $3,634,720.

The final act of Congress relating to the Monongahela Navigation Co., passed June 3, 1896, authorized and directed the Secretary of War to institute and carry to completion proceedings for the condemnation of all the company's property and its appurtenances, and appropriated $5,000, or as much thereof as might be necessary, to pay the necessary cost of said proceedings. In pursuance of this act a board of seven viewers was appointed November 27, 1896, by the Circuit Court of the United States for the Western District of Pennsylvania to estimate and determine the value of all the property and its appurtenances of the Monongahela Navigation Co. The board rendered its report to the court March 25, 1897, awarding damages to the navigation company, including the value of all its property and its franchise, in the sum of $3,761,615.46.

No appeal from this award was taken, and final judgment was entered. A warrant was issued in favor of said company to the amount thereof, less the sum of $160,000 withheld in the United States Treasury as security for the payment of outstanding bonds of the company. On July 7, 1897, the locks and dams and their properties and appurtenances were transferred to the United States and the locks opened to free navigation.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE WHEELING, W. VA., DISTRICT.

---

8. OPERATING AND CARE OF LOCKS AND DAMS ON LITTLE KANAWHA RIVER, W. VA.

The original project, adopted by the river and harbor act approved August 14, 1876, provided for removing rocks, snags, and overhanging trees above Burning Springs, W. Va. (38 miles above the mouth of the river), at a cost of $7,300.

This project was modified by the act of June 14, 1880, which provided for the construction of a lock and dam (No. 5) 2 miles above Burning Springs. The original estimated cost (Annual Report for 1875, pt. 1, p. 740) was $62,000 for a lock of masonry with a wooden crib dam. The actual cost was $167,875 for a lock and dam of stone and concrete. This lock and dam was opened to navigation on December 2, 1891.

The original project was still further modified by the act of March 3, 1905, which provided for the purchase and repair of Locks and Dams Nos. 1 to 4, inclusive, owned by the Little Kanawha Navigation Co., at an estimated cost of $163,000 (H. Doc. No. 309, 58th Cong., 2d sess.; also in Annual Report for 1904, p. 2607, both without maps). The total cost was as follows:

Purchase of locks and dams	$75,000.00
Repairs and improvements	207,059.50
Total	282,059.50

Digitized by Google

More extensive repairs than contemplated and necessary improvements caused the increase over original estimate.

All projects for the improvement of this river have been completed. The total amount appropriated is $496,663.60 (including $2,245.60 received from sales) and the total expenditures are $496,663.60.

4. OPERATING AND CARE OF LOCKS AND DAMS ON KANAWHA RIVER, W. VA.

The original project, adopted by the act approved March 3, 1873, provided for removing large bowlders from the channel, excavating channels through the shoals, and constructing riprap dams and dikes, the object being to increase the depth of water on the shoal places, so as to enable towboats to use the stream for a longer period each year than its natural condition permitted. The amount expended under this project was $50,000.

This project was modified by the act approved June 12, 1875 (Annual Report for 1875, pt. 2, pp. 90–98). It provided for obtaining a depth of 6 feet of water all the year round throughout the whole river, 97 miles, by the construction of nine locks with movable dams from the mouth in the Ohio, at Point Pleasant, W. Va., up to Paint Creek, about 79 miles above Point Pleasant, and three locks with fixed dams above Paint Creek to Kanawha Falls, the fall of the river above Paint Creek being too great to permit of the advantageous use of movable dams. The estimated cost was $4,071,216.

The project was modified by reducing the total of movable locks and dams from 9 to 8, one of the movable locks and dams originally estimated for in the lower portion of the river having been decided, after more detailed examination, to be unnecessary (Annual Report for 1879, p. 550); also, only two of the three fixed dams have been constructed—Nos. 2 and 3—the construction of No. 1 having been dispensed with until its necessity shall become more apparent. By dropping from the project one fixed and one movable dam, as stated, the first estimate was reduced by about $600,000. However, after appropriations had been made amounting to $2,579,500, a revised estimate was made in 1892 (Annual Report for 1892, pp. 2042–2044) showing that $1,305,700 still remained to be supplied by Congress in order to complete the project. This amount was appropriated by the acts of July 13, 1892, March 3, 1893, and March 2, 1895. The estimate of 1892 was made, however, before the exact site of Lock and Dam No. 11 had been selected, before a thorough knowledge of the amount of dredging between locks was available, and before the passage of the law limiting a day's work of a Government employee to eight hours. A second revised estimate was therefore found necessary in 1896, and the increased amount of it, $273,000, was appropriated in the sundry civil act of June 4, 1897. (Annual Report for 1897, p. 2569.)

With all modifications, the project provided for eight locks with movable dams and two locks with fixed dams, so as to provide a 6-foot navigable depth, at a total cost of $4,158,200.

All projects for the improvement of this river have been completed.

Digitized by Google

Total appropriated	$4,296,949.45
Carried to surplus fund	2,337.20
	4,294,612.25
Received from sales	3,429.68
Total amount expended	4,298,041.93

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE LOUISVILLE, KY., DISTRICT.

1. FALLS OF OHIO RIVER AT LOUISVILLE, KY.—LOUISVILLE & PORTLAND CANAL—LOCK AND DAM NO. 41, OHIO RIVER.

The obstructions in the Ohio River, known as the Falls of the Ohio, are formed by an irregular mass of limestone underlying the bed of the river opposite Louisville, Ky. This mass of rock forms a natural dam, producing a deep pool above and, in low-water stages, a fall of 27 feet from the head to the foot of the falls. In their natural condition these falls were impassable during the larger portion of the year, and at other times, except when the river was very high, navigation over them was difficult and dangerous. There were three natural channels over these obstructions, known as Indiana, Middle, and Kentucky Chutes. The former was the main and the longest channel.

The projects for the improvement of navigation at this locality have had for their object the construction and maintenance of a canal with locks around the obstructions, the improvement of the natural channels through the obstructions, and increasing depth of water and controlling its flow by means of dams.

OLD CANAL.

In 1825 the Legislature of Kentucky granted a charter to the Louisville & Portland Canal Co., authorizing it to construct a canal around the Falls of the Ohio within the State of Kentucky, and among other things prescribed certain rates of toll for its use. Subsequent acts by the same body in 1829 and 1831 extended the time for the completion of the canal and increased the capital stock of the company, which finally reached $1,000,000. Under acts of Congress of May 13, 1826, and March 2, 1829, the Government purchased 2,335 shares of the 10,000 shares of the company, paying therefor $233,500.

The canal as originally constructed by the company was 1.9 miles long and 64 feet wide, with three locks in series at the foot of the canal, each with a lift of 8 feet 5¼ inches, a width of 50 feet, and a length of about 200 feet. The first boat passed through the canal December 22, 1830.

The cost of the original canal, including the land, was $1,019,277.09. During the period 1831–1841 tolls to the amount of $1,025,345.45 were collected, and during the period 1834–1842 cash dividends to the amount of $822,539 were paid, of which the Government received $257,778 in addition to 567 shares of stock in lieu of dividends.

Digitized by Google

In 1842, with a view to eventually freeing the canal of tolls, the canal company's charter was amended, authorizing the appropriation of its net income to the purchase of the stock of the company held by individuals, the stock so purchased to be held in trust until all the outstanding shares held in the name of others than the Government should be purchased, when all the shares were to be transferred to the Government on condition that the Government would levy only sufficient tolls to keep the canal in repair, pay necessary expenses, make necessary improvements, etc. During the period 1843–1854, 7,093 shares of stock were purchased by the company at a cost of $1,419,062. At the end of this period 5 shares were held by the directors individually, 7,093 by directors in trust for the United States, and 2,902 by the United States.

In 1844 an act was passed by the Kentucky Legislature providing that in the event of the United States becoming the sole owner of the canal the canal should be yielded up to the Government.

NEW CANAL.

In 1857, the canal proving to be inadequate to the needs of navigation, and the United States having failed to assume control, the company's charter was amended so as to authorize it to construct a branch canal and enlarge the old one with the revenues and on the credit of the corporation. Congress, by act of May 24, 1860, ratified the action of the Kentucky Legislature in amending the company's charter with the proviso that the officers of the company should in no way use or pledge the faith or credit of the United States, and that when the enlargement was completed and paid for no more tolls should be collected than an amount sufficient to keep the canal in repair and pay necessary expenses, etc.

Plans for the enlargement were adopted which consisted in widening the canal prism from 64 to 100 feet (subsequently reduced to 85 feet), and lining both sides with a vertical wall 17 feet high; in fixing the depth of water in the canal at the lowest stage at 6 feet; in removing the abrupt angle in the canal and substituting a regular, easy curve; in providing three passing places; in constructing a guard gate at the head; in constructing a dam or crib protection of timber and stone, about 600 feet long, extending eastwardly from the head of the canal, and removing all projecting points of rocks inside of it; in providing a floating boom at the head of the canal to exclude ice and drift; the new locks to be placed 1,500 feet below the old locks, and be connected with the old canal by a branch 2,600 feet long, the locks to be two combined, each with a lift of 13 feet, and the rocks at the foot of the canal to be removed to open a wide and safe channel.

Work was begun on the enlargement in 1860, but the corporation, after expending about $1,825,403, was compelled to suspend operations in 1866, through lack of funds.

Congress, by act of July 25, 1868, provided for the completion of the canal in accordance with the then adopted plans, and assumed the payment of the canal bonds, on condition that all title and right in the canal should be ceded and vested in the United States. Under this act and subsequent appropriation acts the work was completed by the United States practically as originally designed, and provided a depth of 6 feet in the canal by means of excavation and a guiding

Digitized by Google

dike and cross dam at the head of the canal; a width of 86½ feet between vertical walls 15 to 17 feet high; two locks in series, each 372 feet between quoins, or 348 feet available length, 80 feet wide, with 13½ feet lift. The new locks were opened to navigation February 26, 1872. The cross dam raised the pool about 3 feet.

The Kentucky Legislature, by a joint resolution approved March 28, 1872, directed the transfer of the canal and property to the United States under certain conditions. The act of Congress of March 3, 1873, provided for the assumption of the control and management of the canal by the United States in conformity with the last-named resolution. The act of May 11, 1874, provided for the payment of the debts of the canal company, purchase of stock held by the directors, etc., and for taking possession of the property, and provided that the canal should be held "free of all tolls and charges except such as are necessary to pay current expenses of said canal, and keep the same in repair." The act of May 18, 1880, directed that "no tolls shall be charged or collected at the Louisville & Portland Canal."

The United States assumed charge of the work of enlargement following an allotment from the act of July 25, 1868, but the operation of the canal and collection of tolls remained under the control of the corporate management until June 11, 1874, upon which date the entire control of the canal was taken over by the United States pursuant to the act of May 11, 1874.

Tolls were abolished after midnight July 1, 1880, since which date the expenses of operation and maintenance of the canal have been borne by United States Treasury funds made available by the river and harbor acts of March 3, 1881, July 5, 1884, and March 3, 1909.

COST OF NEW CANAL.

Old canal, private corporation		$1,019,277
Improvements, private corporation (about)		120,000
Total cost of old canal		1,139,277
Enlargement, private corporation		1,825,403
Enlargement, canal tolls collected and expended by the Government (about)		150,000
Enlargement, Government funds (completion of new locks, enlargement of canal, cross dam at head of canal, payment of bonds, etc.):		
Act July 25, 1868, allotment	$85,000	
Act Apr. 10, 1869, allotment	178,200	
Act July 11, 1870, appropriation	250,000	
Act Jan. 18, 1871, appropriation	200,000	
Act Mar. 3, 1871, appropriation	250,000	
Act June 10, 1872, appropriation	300,000	
Act Mar. 3, 1873, appropriation	100,000	
Act Mar. 3, 1875, appropriation	100,000	
		1,463,200
Total cost of canal (including locks and appurtenances)		4,577,880
Cost to Government, original stock purchase		233,500
Cost to Government, enlargement		1,463,200
Canal enlargement bonds assumed		1,172,000
Total expenditure		2,868,700
Deduct cash dividends received		257,778
Total cost to Government		2,610,922

Digitized by Google

Practically all of the historical data given above has been extracted from the special report of Maj. G. Weitzel, Corps of Engineers, dated February 10, 1882. This report may be found in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1882, pages 1880–1902, and in Senate Executive Document No. 129, Forty-seventh Congress, first session.

There was included in the report referred to the following list of "additional works necessary at the falls of the Ohio River to complete the improvements thereof in a manner to serve the interests of the commerce of said river."

(*a*) About 1,300 feet in length additional of the permanent dam, as designed and partially constructed across the Ohio River on the crest of the falls, should be converted into movable dams.

(*b*) The entrance to the head of the canal should be very much enlarged.

(*c*) Additional canal accommodations around or over these obstructions should be provided.

(*d*) That portion of the north bank of the existing canal which has thus far been untouched by the work of enlargement should be rectified and new side walls built.

(*e*) A set of gates should be provided in the branch canal just above the new locks for high-water lockage.

(*f*) A new lock should be built with a chamber as wide as the present new locks.

(*g*) A new dry dock should be constructed.

(*h*) The basin above the head of the present lock should be enlarged.

ENLARGEMENTS.

Previous to 1883 the approach to the canal at its upper end, above the Louisville Bridge Co.'s bridge at Fourteenth Street, was so narrow as to constitute a source of much expensive delay to the large quantity of traffic which came down the river on ordinary rises. The canal proper from Ninth to Fourteenth Streets was only 100 feet wide and curved between the two points, so that progress was slow and accidents frequent and unavoidable. The greater part of the dike marking the north side of the approach to the canal was submerged when the river reached a stage of 8.4 feet, upper canal gauge, and at stages of 9 feet or more a strong current set out from the shore, thus carrying many vessels against the dike and, at high enough stages, over it onto the rock ledges. This approach was 1,800 feet long and varied in width from 400 feet at the upper end to 100 feet opposite Ninth Street. Its area was wholly insufficient for the required breaking and rearrangement of tows preparatory to entering or leaving the canal.

Enlargements at the head of the canal.—The first project for additional improvements at the Falls of the Ohio, printed in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1883, page 1539, was adopted by the act of July 5, 1884, and contemplated—

enlarging the present canal by moving its northern wall to the northern line of the canal property, commencing at the pivot pier of the railroad bridge and extending eastwardly to the eastern boundary line of the property of the Louisville Cement Co. At this point will be the new head of the canal, and it will be connected with the existing dam on the crest of the falls by a similar dam along the eastern line of the cement company's property to its northeastern corner, thence by a straight line to the southern end of the opening for the Middle Chute.

Digitized by Google

This project proposed the enlargement of the canal, beginning at a point a short distance below the railroad bridge at Fourteenth Street and extending eastwardly to the cross dam, so as to not only straighten and widen the canal proper, but also provide ample space for the necessary rearrangement of tows about to enter or leave the canal. This was slightly modified in 1885, so far as the location of the new north wall was concerned. A revision of the project was made by a board of engineer officers January 28, 1890, and approved by the Chief of Engineers January 31, 1890. This revision modified the area formerly proposed to be excavated and determined the number and kind of structures, etc., to be erected. As approved, it provided for enlarging the canal on its northerly side from a point 725 feet below the railroad bridge at Fourteenth Street, where the width of the canal was abruptly increased from 90 feet to 210 feet. This latter width is then gradually increased through a distance of nearly 2,800 feet to 325 feet at the head of the canal proper, at which point the enlargement is expanded into a capacious basin or harbor 1,200 feet wide and practically parallel to the Kentucky shore. The structures proposed were a new retaining wall on the north side of the canal, a movable dam about 800 feet long, a fixed dam extending from the movable dam at the westerly end of the basin to the south abutment of the movable dam in the Middle Chute opening of the cross dam, the excavation of rock within designated limits to the same grade as the canal bottom, the construction of certain walls and slope revetment on the south side of the canal, and the removal of the old structures within the limits of the proposed enlargement. Under date of March 31, 1899, a further modification of some of the details of the project was considered by a board of engineer officers and their recommendations approved by the Chief of Engineers April 8, 1899. These later modifications, together with the work outlined in the report, were approved January 31, 1890. The totals of estimates under the original project and the several revisions are as follows:

Project of 1883, page 1539, Annual Report of the Chief of Engineers for 1883	$1,335,363.00
Revision approved Jan. 31, 1890, page 2217, Annual Report of the Chief of Engineers for 1890	710,230.40
Modification approved Apr. 8, 1899, page 2562, Annual Report of the Chief of Engineers for 1899	300,391.92
A revision of the latter estimate was made Nov. 13, 1900, approved by the Chief of Engineers Nov. 17, 1900, and amounted to	398,359.12

The foregoing relates particularly to the improvements at the head of the Louisville & Portland Canal.

Enlargement of basin above locks.—By the act of August 5, 1886, the project for the enlargement of the upper portion of the canal was made to include the enlargement of the basin of the canal just above the locks, as recommended in the "last report of the engineer in charge." (Annual Report for 1885, p. 1804.) This work consisted in widening that part of the canal which extends from the new locks to the basin above, a distance of about 800 feet, from 90 feet to 215 feet. The work was estimated to cost $120,000. It was begun in 1887 and completed in 1893.

Digitized by Google

IMPROVEMENTS TO NAVIGATION OVER THE FALLS.

Originally there were three natural channels over the falls, known as the Indiana, Middle, and Kentucky Chutes. The former was the main channel and ran near the Indiana shore, between it and Goose Island, making a large bend near the foot of the fall, called the Big Eddy. It was 2⅜ miles long. At extreme low stages about one-half of its total fall, 13 feet, occurred in the first $\frac{7}{10}$ mile and about two-thirds of its fall, 17½ feet, occurred in the first 1¼ miles. When the water rose 7 feet at the crest of the falls above extreme low water it rose about 18½ feet at the foot of the channel, the difference in level between the two pools being about 13½ feet. The Middle Chute began about the middle of the river and passed down between Goose and Rock Islands. The length of this channel was 2⅛ miles, and about 22 feet, or almost the entire fall, was in the last 500 yards. The Kentucky Chute lay nearer to the Kentucky shore and passed down between it and Rock Island. Almost the entire fall was in the last 185 yards. (Annual Report for 1882, p. 1881.)

Indiana Chute.—All of the work for the improvement of navigation over the falls has been devoted to widening and deepening the Indiana Chute Channel and controlling the flow through it by means of a dam at the head of the canal and the construction of dikes along its course. This channel was originally very crooked and filled with dangerous rocky points.

A dam from the Indiana shore to the head of Sand Island was completed in 1872, but subsequently abandoned. In 1879 some of the worst obstructions in the channel were removed. Between 1880 and 1890 much work, consisting in the removal of some of the more dangerous rock ledges, was accomplished under estimates and allotments for improving Ohio River.

Prior to January 31, 1890, there was no specific comprehensive project for the systematic improvement of the Indiana Chute Channel. On that date the project submitted by a board of engineer officers for the radical improvement of this chute was approved by the Chief of Engineers. This project had for its object the widening and deepening of the channel by rock excavation to specified grades within certain limits and the control of water flow in the channel by means of dikes, etc., so as to make this channel available for descending navigation drawing 6½ feet at stages of 8 feet, upper canal gauge. However, only a part of the work necessary for the purpose in view was included in the estimate accompanying the report of the board, it being stated:

> As the exact knowledge of the results of that work [i. e., the work estimated for in the board's report] would be of great importance in fixing the details of location and cross section of the additional works that will be required, it would be as well to leave the determination of the additional work above the bridge to a later day.

The estimates for work on this chute since the adoption of a specific project therefor are as follows:

Project approved Jan. 31, 1890	$138,610.97
Modification approved Apr. 8, 1899	74,320.98
Revision of estimate approved by the Chief of Engineers Nov. 17, 1900	129,651.99

Digitized by Google

A consolidation of the projects for the enlargement at the head of the canal and the improvement of the Indiana Chute was authorized by the Chief of Engineers June 28, 1897, and since that date funds were provided for work at both localities under one title of appropriation.

Work under that part of the project relating to the Indiana Chute having been completed, a board of Engineer officers was assembled to determine, as anticipated in the project of 1890, what further work was essential to provide the requisite depth necessary to facilitate the passage of traffic through this channel. The report of the board was submitted December 16, 1901, and approved by the Chief of Engineers December 30, 1901. The items of additional work found to be necessary to produce the desired result and the estimated cost thereof are as follows:

Submerged dam at Whirlpool Point (large stone), 2,500 cubic yards, at $3	$7,500
Raising movable dam north of canal wall	2,500
Removing old dam and building movable dam, 1,000 feet, at $75	75,000
Longitudinal contracting dikes (concrete), 22,300 cubic yards, at $12	267,600
Submerged dams below bridge (concrete), 3,000 cubic yards, at $20	60,000
Rock excavation, 3,200 cubic yards, at $3.50	11,200
Contingencies, 10 per cent	42,380
Total	466,180

For this latter work the board prescribed the order in which it should be done, and stated that it was possible that a part of the work might become unnecessary if certain results were produced by the submerged dam at Whirlpool Point, and in that event about $125,000 would probably be saved from the estimated cost.

NEW PROJECT FOR ENLARGEMENT OF THE CANAL, RECONSTRUCTION OF DAMS, ETC.

In House Document No. 492, Sixtieth Congress, first session, the Ohio River board recommended the omission of all of the foregoing items except that for removing the old dam and building a movable dam at the head of the falls (No. 41 of the series), and in lieu of such omitted items proposed the following to increase the facilities for passing the falls:

(1) To widen the narrow portion of the canal to 170 feet, thus permitting the passage of a downbound tow of loaded coal boats and an upbound tow of empty coal boats, each tow three abreast; (2) to construct a new single-lift concrete lock south of and by the side of the present lock, available dimensions of the chamber to be 85 feet by 600 feet, thus permitting the passage at one lockage of 9 coal boats or 12 coal barges; (3) to create a pool above the falls, with elevation of pool surface at 412.004 (9 feet on upper canal gauge), by the replacing of the wooden dam between Middle and Indiana Chutes by a Boulé Dam, with crest at 412.004, which work is already provided for and under way, and by the construction of the sections of dam recommended by the district engineer officer in the project approved by the Chief of Engineers on December 28, 1903, with crests at 412.004 instead of 411.004, recommended therein, this height of crest being desirable for either a 6-foot or a 9-foot slack-water navigation, or even if the river is not further improved by the slack-water method; (4) to remove the rock necessary to complete the widening of the basin at the head of the canal contemplated by the present approved project; (5) to reconstruct the three sections of Boulé Dam just north of the head of canal with crest at 415.704, instead of crest at 412.504, as provided for in present project, thus eliminating the cross current across the head of the canal, which current now

Digitized by Google

makes it very difficult for tows to enter the canal at stages between 8 and 12.7 feet. It is proposed to leave the crest of the present fixed concrete dam at 411.004 to serve as a fixed weir for the low-water discharge of the river.

All elevations are in feet above mean tide at Sandy Hook, N. J.

The estimated cost of the work proposed by this board is as follows:

Widening canal to 170 feet, etc	$673,000
New locks and appurtenances	773,000
New dams	240,000
Reconstructing Boulé Dam at head of canal	31,000
Removal of rock in basin	43,000
Total	1,760,000

The river and harbor act of June 25, 1910, adopted a canalization project for the entire river, in accordance with report printed in House Document No. 492, Sixtieth Congress, first session, or such modifications thereof as, in the discretion of the Secretary of War, might be advisable. This project includes the canal widening and new lock (items 1 and 2 of above estimate).

In order that Lock and Dam No. 41 might be of the same dimensions as the other locks and dams on the Ohio River, and in order that future navigation might be adequately provided for, the Secretary of War, under date of March 24, 1911, exercised the authority granted him by the act of June 25, 1910, and approved a modification of the approved project by increasing the canal prism from 170 feet to 200 feet, and by increasing the width of the new lock (No. 41 of the series) from 85 feet to 110 feet, at an increase in cost of $431,500.

EXISTING PROJECT.

As now approved the existing project proposes: (1) To widen the narrow portion of the canal to 200 feet; (2) construct a new single-lift concrete lock south of and by the side of the present lock, available dimensions of new lock to be 110 feet by 600 feet; (3) remove certain rock from basin at head of canal; and (4) create a pool above the falls, with elevation of pool surface at 412.004 (9 feet on upper canal gauge), by the reconstruction of old sections and building new sections of dam where none previously existed.

The estimate for this work is itemized as follows:

Widening the canal to 200 feet, etc	$936,031
New lock and appurtenances	1,710,325
New dams and reconstructing Boulé Dam at head of canal	271,000
Removal of rock in basin	43,000
Total	2,960,356

The act of March 2, 1907, provided for the completion of the third and fourth items. This work has been done, leaving only the first and second items as the remainder of the existing project to be completed, for which the estimate amounts to $2,646,356.

PRESENT CONDITIONS.

All of the projected works of navigation at the Falls of the Ohio were finally completed in 1911, except the widening of the canal to

Digitized by Google

200 feet and the construction of a new lock, etc., now included in the canalization project for the entire river.

The successive improvements at this locality have resulted in the completion of the following works:

Louisville & Portland Canal.—Length, including locks and lower entrance, 2¼ miles; width, at Louisville Harbor, 800 feet; upper entrance to canal, 400 feet, reducing to 200 feet; throughout the canal, 86½ feet; at the basin above the locks, 215 feet; minimum depth of water in the canal, 9 feet.

Locks.—These locks, two in series, are 372 feet long between quoins, with available length of 348 feet, and are 80 feet wide, and have wooden mitering gates. The locks have a maximum lift of 34 feet, divided between the two.

Plant.—This includes office buildings, superintendent's dwelling, warehouses, stable, shops for the repair of operating machinery, dam trestles, wickets, boats, etc., 2 towboats, 2 maneuver boats, 2 dredges, and auxiliary craft.

Dam.—This is 5,247 feet long, and extends across the river at the head of the canal. It is part masonry, part concrete, and part movable. When in operation it gives at all times a depth of 9 feet in the harbor and canal and provides that depth upstream for 50 miles to Madison, Ind.

Indiana Chute Channel.—This channel over the falls is about 400 feet wide and can now be navigated with ease by heavy-draft coal boats at stages of 11.5 feet or more, upper canal gauge.

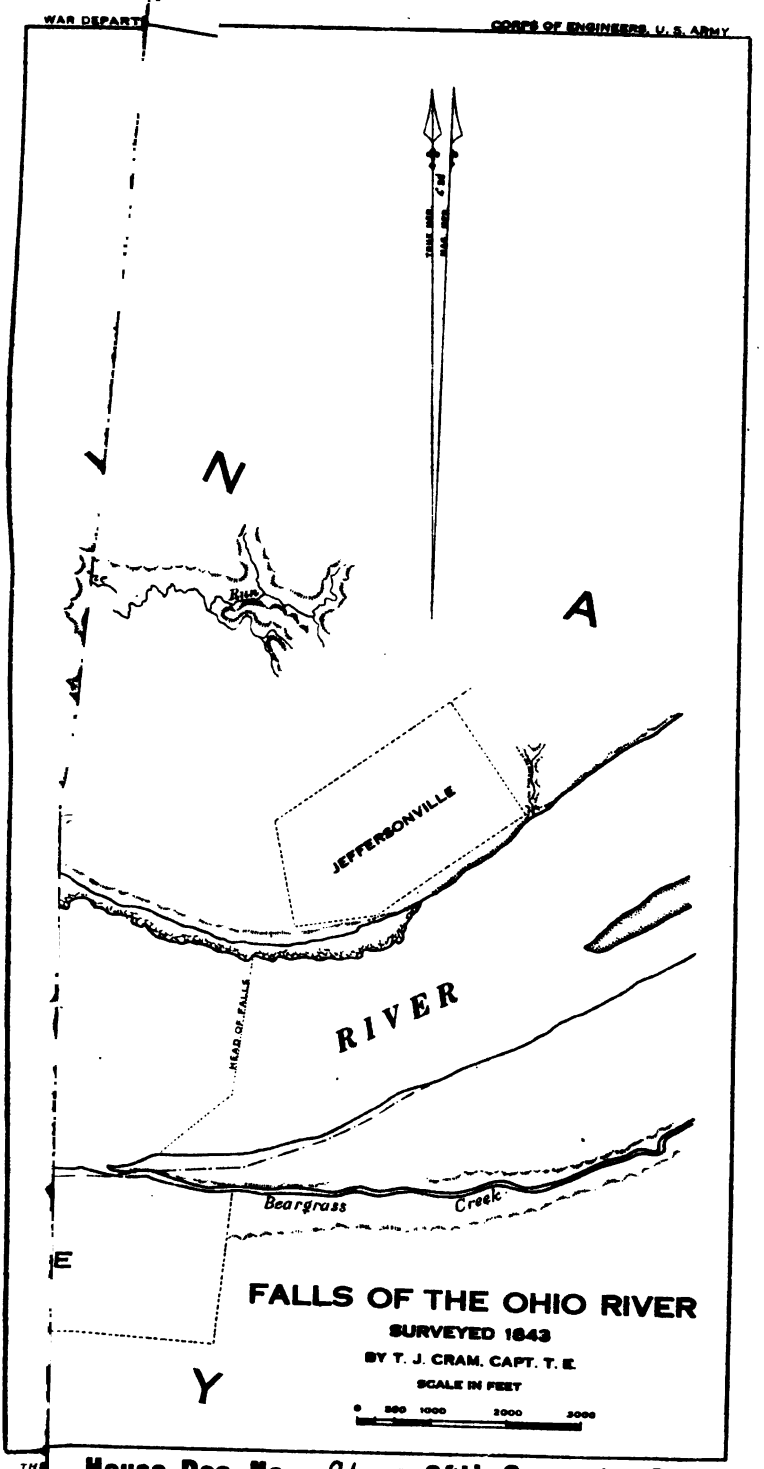
RESULTS OF THE PRESENT IMPROVEMENT.

Navigation past the Falls of the Ohio at all stages of the river has been made possible to boats drawing 8 feet or less. The canal is available to commerce at all stages of the river less than 12.7 feet, upper canal gauge, and affords free navigation around the falls at all stages of water when the passage can not be made by the river channel. The zero of the upper canal gauge is 403.004 feet above mean tide at Sandy Hook, N. J.

COST OF THE COMPLETED IMPROVEMENTS.

Cost to the United States of the "new canal," as originally completed		$2,610,922.00
Expenditures for subsequent improvements:		
Expended from allotments, 1881, to Jan. 31, 1890		116,049.80
Expended under project of 1883, for enlargement of head of canal, to Jan. 31, 1890		347,380.68
Reserved, Office Chief of Engineers, United States Army		1,874.20
Expended under project for enlarging canal basin at locks		133,000.00
Expended under revised project of Jan. 31, 1890, to June 30, 1897—		
On enlargement at head of canal	$298,856.35	
On Indiana Chute Channel	103,602.81	
		402,459.16
Expended under appropriations for enlargement at head of canal and Indiana Chute, in accordance with project of Jan. 31, 1890, to Mar. 31, 1899		208,659.75
Expended under appropriations for enlargement at head of canal and Indiana Chute, in accordance with the modified project of Mar. 31, 1899 (approved Apr. 8, 1899)		459,075.27

Digitized by Google



House Doc. No. 91 ; 64th Cong., 1st Sess.

Digitized by Google

Digitized by Google

Expenditures for subsequent improvements—Continued.	
Expended under the project recommended by the Ohio River Board, as modified by the Secretary of War, exclusive of the amounts expended for widening the canal and building a new lock under the present Ohio River canalization project	$313,650.00
Total cost to the United States	4,593,070.86
Expended by private company	1,966,858.00
Total cost of improvements	6,559,928.86

In addition to the foregoing, there has been expended to June 30, 1915, on the work of widening the canal to 200 feet and building the new lock, etc., the sum of $1,275,229.28, making the total cost of all new work at this locality $7,835,158.14, of which the United States expended $5,868,300.14.

References to more extended information concerning original condition, purchase, and progress of the improvement of this canal are given on page 491, Annual Report of the Chief of Engineers for 1904.

Reports upon examinations and surveys may be found as follows:

Report of W. D. Gallagher, special agent, Treasury Department, September 30, 1867, concerning interest of the United States in the Louisville & Portland Canal, legislation, financial affairs, condition of work, etc. (H. Misc. Doc. No. 83, 40th Cong., 2d sess.)

Report of the House Committee on Railways and Canals, recommending that the Louisville & Portland Canal be made free from toll. (H. Rept. No. 348, 46th Cong., 2d sess.)

Special report made in response to resolution of the Senate of the United States calling for information as to "what, if any, additional works are necessary at the Falls of the Ohio River to complete the improvement thereof in a manner to serve the interests of the commerce of the Ohio River," etc. (Annual Report Chief of Engineers for 1882, p. 1880.) This report briefly describes original condition, the construction of the canal by the stock company, conditions at the time the United States assumed charge of the improvement of the canal, discusses additional works deemed necessary, and gives estimates of cost. The report, accompanied by the maps referred to in it, may also be found in Senate Executive Document No. 129, Forty-seventh Congress, first session.

Report on drainage rights, Louisville & Portland Canal, accompanied by map showing location of sewers emptying into the canal. (H. Ex. Doc. No. 51, 49th Cong., 2d sess.) The report with map omitted may also be found on page 1852, Annual Report Chief of Engineers for 1887.

Report as to whether or not the Government dry dock at the Louisville & Portland Canal is adequate for the purposes of commerce, and what alterations, if any, are necessary, and the cost of making same. (Pp. 1896–1901, Annual Report Chief of Engineers for 1887.)

2. WABASH RIVER, IND. AND ILL., LOCK AND DAM AT GRAND RAPIDS, WABASH RIVER.

At the time the United States began the work of improving this river it was badly obstructed by bars, accumulations of snags, rocky reefs, and numerous secondary channels or cut-offs, which lessened

Digitized by Google

the flow of water through the main channel. Navigation was impracticable except at high stages of water. A lock and dam had been built at Grand Rapids by the Wabash Navigation Co. and a few improvements made at other places, also by private enterprise; but as none of them was of a substantial character, they rapidly deteriorated and became useless.

The original project and outline of improvements proposed is found in the report of Maj. G. Weitzel, Corps of Engineers, January 4, 1872, page 472, Annual Report of the Chief of Engineers for 1872. The first appropriation for work under this project was made by Congress June 10, 1872. This project proposed the improvement of the river from its mouth to Lafayette, Ind., by special works at 12 designated localities, the construction of a new lock and dam at Grand Rapids, and the general work of snagging and dredging. The estimated cost of the work proposed amounted to $312,672.62. Work at various places other than those mentioned in the project was added from time to time, but no general revision of the original estimate was made.

The river and harbor act of March 3. 1881, made separate appropriations for work above Vincennes and for work below Vincennes, thus dividing the original project, and subsequent to that date funds have been provided separately for each section.

From the commencement of the work, in 1872, to March 31, 1881, the expenditures, all of which were for work below Vincennes, amounted to $324,845.44. Those for work since that date are given under their respective headings, as follows:

(*a*) *Below Vincennes.*—Subsequent to 1881 work was continued under the original project, but the estimates were modified from time to time as necessity therefor arose, as in the cases for the dam for closing the New Harmony Cut-off, the lock and dam at Grand Rapids, etc. Levee work at Grayville, Ill., was added in 1887, and completed, as proposed, at a cost of $25,000. In 1898 a plan and estimate amounting to $50,000, for additional work at New Harmony was approved, but at the same time it was urged that if the improvement of the river was to be continued the old project should be abrogated, a comprehensive survey of the river made, and a new project formulated, based upon data furnished by the survey and of sufficient scope to meet existing needs of commerce. The survey was authorized and funds therefor provided by the river and harbor act of June 13, 1902. The report on the survey, proposed plan for improvement, estimate of cost, and action taken in connection therewith may be found on page 2729, Annual Report of the Chief of Engineers for 1904. The aggregate of the items of the original estimate applicable to this part of the river and of the several subsequent estimates constituting the estimate of cost of existing project adopted by Congress is $755,000.

The expenditures to March 31, 1881, amounted to $317,845.44, in addition to the $7,000 paid to extinguish the franchise of the Wabash Navigation Co. and acquire their property, those for the levee work at Grayville from 1887 to 1892, $25,000, and those for other work since 1881 on this part of the river, $365,111.76, or an aggregate of $714,957.20 for work below Vincennes to June 30, 1909.

Digitized by Google

Previous to 1885 a fairly good channel for boats having a draft not exceeding 2½ to 3 feet was maintained, but as the river and harbor act of July 5, 1884, made specific appropriation for a lock and dam at Grand Rapids, near Mount Carmel, Ill., the suspension of operations elsewhere became necessary, in view of the fact that the funds available since that date were not sufficient to complete the lock and dam, and at the same time maintain the former works for bank protection and to concentrate the water flow and clear the channel of obstructions. Consequently the work formerly done deteriorated rapidly, the structures being destroyed by ice and high water or rendered useless by the water cutting its way around them. The channels, cut through rock reefs and shoal places, became choked with snags, stumps, and bowlders, thus leaving the river without any permanent improvement excepting that resulting from the lock and dam at Grand Rapids. Through navigation at low water is impracticable. Boats drawing 20 inches can pass from Mount Carmel to Vincennes (a river distance of about 34 miles) at all stages, but can reach Mount Carmel, 92.7 miles from the mouth of the river, only when the gauge at the lock reads 7.5 feet or more.

(*b*) *Above Vincennes.*—At the time this section of the river became the object of separate appropriations there had been no revision of the estimate in the original project for the improvement of the river from its mouth to Lafayette. Under the project matured after the appropriation had been made (see Annual Report of the Chief of Engineers for 1881, p. 2001), and subsequent modifications, the estimates to June 30, 1908, amounted to $95,500.

The expenditures on the work of the last project to June 30, 1909, amounted to $95,254.87.

The funds available since 1893 were not sufficient to maintain the former works for channel rectification and to keep the river clear of snags, bars, and similar obstructions, and during the more recent years funds available were insufficient for snagging purposes alone. Therefore it can not be said that any permanent improvement of this section of the river has been effected or that navigation is practicable, except at high stages of water.

There is at present no approved comprehensive project in force for the improvement of Wabash River. On June 30, 1909, the unexpended balances of the appropriations were carried to the surplus fund of the Treasury, and no funds for this purpose have since been provided. (Annual Report for 1909, pp. 652 and 655.)

LOCK AND DAM AT GRAND RAPIDS, WABASH RIVER.

This lock has been under operation since 1893. It is located 97 miles above the mouth of the river. Slack water extends only about 12 miles above the lock. The dam is unusually long for a small stream.

Expenditures.—The total expenditure by the Government for improving Wabash River is as follows:

Below Vincennes	$714,957.20
Above Vincennes	95,254.87
	810,212.07

Digitized by Google

References to more extended information are given on pages 494 to 496, Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1904.

3. GREEN AND BARREN RIVERS, KY.

Green and Barren Rivers lie wholly within the State of Kentucky, and, with their tributaries, drain an area of about 10,000 square miles. About 1835 the State of Kentucky undertook the improvement of these rivers by locks and dams. Six locks and dams in Green River and one in Barren River were placed under contract, but of these only four in Green and one in Barren River were completed. The slack-water system as completed by the State was opened to navigation in 1841. The first lock and dam on Green River was placed at Spottsville, 8¼ miles from the Ohio; the second at Rumsey, 51¾ miles from the first; the third at Rochester, 43½ miles from the second; and the fourth at Woodbury, 41½ miles from the third. The lock in Barren River was placed at Green Castle, 15 miles from Lock No. 4, Green River. These five locks and dams, together with the backwater from the Ohio, gave continuous navigation for a draft of 4 feet from the Ohio River to Bowling Green, a distance of 175 miles. They were operated by the State until 1868.

In 1868 an act of the Kentucky Legislature granted a charter to the Green & Barren River Navigation Co., transferring to that company the control of the Green and Barren improvements for a period of 30 years. This act, which was subsequently amended in 1876 and 1878, regulated rates of toll for passage through the locks. The tolls for a boat of 150 tons, whether loaded or light, amounted to about $360 for a trip from the mouth of Green River to Bowling Green and return. Passenger charges on the company's boats amounted to from 3 to 10 cents per mile, according to the distance traveled. (Annual Report for 1885, p. 1905.)

In 1886 an act of the Kentucky Legislature ceded the entire system to the United States, upon condition that the unexpired portion of the lease to the navigation company be purchased by the United States. The river and harbor act of August 11, 1888, appropriated $135,000 "for the purchase of the Green and Barren River improvements." The purchase was made accordingly, and the Government assumed control of the river, the improvements therein, and the property formerly owned by the State December 11, 1888.

When the United States assumed control the condition of the improvements was as follows:

Lock and Dam No. 1, Green River, required many repairs. The walls of Lock No. 2 were cracked and in bad condition generally, the land wall especially so, it being held in position by anchorage to cribs filled with stone; the river wall had yielded outward. Lock No. 3, Green River, was broken entirely, the river wall having yielded outward and fallen into the river. Lock and Dam No. 4, Green River, was in fairly good condition, with the exception of needed repairs to the quoins and gates. The walls of Lock No. 1, Barren River, were so badly cracked that a part of one of them, the land wall, leaned toward the lock chamber about 6 inches and was liable to fall at any time. The entrances to the locks were obstructed

Digitized by Google

with deposit and the pools with great numbers of snags, overhanging trees, etc.; the appurtenant structures at the locks and the lock tenders' dwellings were in bad condition and inadequate. No snagging nor dredging plant was available.

Since the assumption of control by the United States the structures of the former system were restored to first-class condition, and two new locks and dams, Nos. 5 and 6, on Green River above the mouth of Barren River, were added to the system.

Excepting the funds for rebuilding Lock No. 2, Green River, which were provided by specific appropriations, the funds for the restoration of former structures, the operation of the locks, and maintenance of the system in good navigable condition have been provided by allotments from the indefinite appropriation for "Operating and care of canals and other works of navigation," act of July 5, 1884, as amended and reenacted by section 6 of the river and harbor act of March 3, 1909, under estimates submitted annually at the beginning of each fiscal year. The first project for work on these rivers under the former act was approved January 4, 1889, and proposed the restoration, so far as practicable, of the former structures to good serviceable condition, the construction of new ones where required, the operation of the locks, the removal of snags, landslides, and deposit from the entrances to the locks, etc., and such has been the general object of each subsequent annual estimate and project.

Lock No. 2, Green River, at Rumsey, Ky.—The deficiency act of March 3, 1893, appropriated $65,000 for rebuilding this lock, which in 1892 had been reported unsafe for navigation. The subproject for the work, approved in 1893, provided for the construction of a new lock, on the river side of the old lock, with certain changes in existing conditions to conform to the new location. (Annual Report for 1900, p. 509.) The original estimate of the cost of this work was $170,000. An additional appropriation of $105,000 for completing the work was made by the river and harbor act of August 17, 1894, and the lock was completed in 1895.

Green River, above the mouth of Big Barren River.—Originally this part of Green River was much obstructed by snags, large bowlders, and overhanging trees. Dam No. 4, Green River, afforded slack-water navigation for about 18 miles above the confluence of Green and Barren Rivers. The fall in that part of the river above slack water and below Mammoth Cave, a distance of 29 miles, was approximately 27 feet. (Annual Report for 1910, p. 727.)

A project for the extension of slack-water navigation from the upper limits of pool No. 4 to Mammoth Cave by the construction of two locks and dams, at an estimated cost of $361,346.40 each, was submitted by Maj. D. W. Lockwood, Corps of Engineers, August 11, 1891. (Printed in Annual Report for 1891, p. 2481.) This project, as to Lock No. 5, was adopted by the river and harbor act of July 13, 1892, and as to Lock No. 6 by the river and harbor act of June 13, 1902. No revision of the project or estimate was made, except as provided by the river and harbor act of March 3, 1905, for work of snagging and clearing the banks of that part of Nolin River which would be affected by slack water from Dam No. 6, Green River. For this purpose the sum of $5,000 was made available. Lock No. 5 was completed in 1899 and Lock No. 6 in 1905.

Digitized by Google

EXPENDITURES.

Purchase of original improvements, appropriation Aug. 11, 1888		$135,000.00
Operation and maintenance, including restoration and repair of original structures:		
From allotments from the indefinite appropriation for operating and care, etc., acts of July 5, 1884, and Mar. 3, 1909	$1,989,515.46	
Appropriations for rebuilding Lock No. 2—		
Act of Mar. 3, 1893	65,000.00	
Act of Aug. 18, 1894	105,000.00	
		2,159,515.46
New work:		
Appropriations for construction of Locks Nos. 5 and 6—		
Act of July 13, 1892	50,000.00	
Act of Aug. 18, 1894	25,000.00	
Act of June 3, 1896	20,000.00	
Act of Mar. 3, 1899	85,673.20	
Act of June 13, 1902	180,000.00	
Providing for snagging in Nolin River, act of Mar. 3, 1905	5,000.00	
	365,673.20	
Deduct amount carried to surplus fund of the Treasury	245.04	
		365,428.16
Total to June 30, 1915		2,659,943.62

4. ROUGH RIVER, KY.

Shortly after the Civil War a stock company built a timber-crib lock and dam on the river about 8 miles from its mouth that gave slack-water navigation to Hartford, Ky, a distance of 29½ miles from the mouth of the river. The venture ultimately proved to be unprofitable, and the structures were abandoned by the company. At the time the Government undertook the work of improvement the dam had been torn out and the lock was in ruins. A project, with estimate, submitted by Capt. James C. Post, Corps of Engineers, January 27, 1885 (Annual Report for 1885, p. 1894), providing for clearing the river of obstructions and the construction of a lock and dam to carry slack water to Hartford, Ky., was adopted by the river and harbor act of September 19, 1890. The subproject and estimate were subsequently modified in 1891 and 1895, changing the dimensions of the structures and substituting a concrete lock and abutment for the masonry lock and timber abutment originally proposed. The lock was completed in 1896 and the removal of the obstructions contemplated in the project in 1899. The lock and dam afford slack water to Hartford, Ky., for boats not exceeding 123 feet in length, 27 feet in width and draft not exceeding 4 feet at pool stage. The lock was opened to navigation December 12, 1896, and has been in operation since that date.

EXPENDITURES.

Construction of lock and dam and removal of obstructions	$105,500

The reports on examination and survey, with original estimates, State laws, etc., may be found in the Annual Report of the Chief of

Digitized by Google

Engineers for the fiscal year ending June 30, 1885, pages 1893 to 1903.

For drawing, showing general plan and sections of lock, and framing for concrete forms, see the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1896, page 2280.

HISTORICAL SUMMARY, GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE SECOND CINCINNATI, OHIO, DISTRICT.

---

8. BIG SANDY RIVER AND TUG AND LEVISA FORKS, W. VA., AND KY.

The original project, adopted in the act of June 18, 1878, provided for the removal of rocks, snags, and overhanging trees on the main river and Tug and Levisa Forks.

The project was based on House Document No. 75 (Pt. 10), Forty-third Congress, second session (Annual Report for 1875, Pt. 1, pp. 756–769) which contained a report of examination and survey of the river from its mouth to Piketon (Pikeville) and to Warfield, in Kentucky, made in compliance with provisions of the river and harbor act of June 23, 1874. This report recommended, in addition to the removal of channel obstructions, the canalization of the river by the construction of 22 locks and dams at an estimated cost of $1,922,536, but it was not until 1880 that this latter feature of the improvement was undertaken.

By the act of June 14, 1880, the project was modified to provide for a lock and fixed dam near Louisa, Ky., continuing in force the project for removing obstructions. At the close of the fiscal year ending June 30, 1892, the lock had been completed and equipped, the abutment had been constructed, and a part—80 feet—of permanent dam had been constructed. The construction of a fixed dam was, at this period of the work, opposed by the timber and shipping interests, and, under date of May 20, 1891, a board of engineer officers was constituted by Special Orders No. 31 "to consider and report upon the subject of the dam to be built in the Big Sandy River." In its final report (Annual Report for 1892, p. 2102) the board recommended the substitution of a needle dam in place of a fixed dam, and by the act of July 13, 1892, the project was modified to provide for the dam to be movable.

The whole work was completed in 1896 at a total cost of $356,590.66.

HISTORICAL SUMMARY, GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE DULUTH, MINN., DISTRICT.

3. HARBOR AT DULUTH, MINN., AND SUPERIOR, WIS.

The original project adopted by the river and harbor act of March 2, 1867, was for Superior City Harbor and provided for a rock protection to the beach on Minnesota Point, narrowing gradually the outlet of the bay to 350 feet by cribwork, constructing two parallel piers composed of stone-filled cribs, the weather pier (Wisconsin)

Digitized by Google

extending to 18-foot depth of water in the lake, all at a total estimated cost of $263,300. (Annual Report for 1868, pp. 26 and 81.) There was expended under this project about $258,000. (Annual Report for 1886, p. 1633.)

The project adopted by the river and harbor act of March 3, 1871, was the first project in which reference is made to Duluth. It provided for the extension of the 400-foot breakwater (originally built by the Northern Pacific Railway Co.) by adding 2,622 feet to its length, at an estimated cost of $387,252.89. This breakwater was abandoned in 1872, after being wrecked by a storm. But little use has been made of the outside harbor since. There was expended, under the project of 1871, $110,000. (Annual Report for 1870, pp. 38, 125; for 1871, pp. 30, 107; and for 1886, p. 1628.)

The project adopted by the river and harbor act of March 3, 1873, provided for dredging in the Bay of Superior from the natural entrance to the docks of Superior and Duluth and preserving both lake entrances. (Annual Report for 1873, p. 129.) The original estimate was $269,739.25. The object was to maintain the Superior entrance and the canal built by the city of Duluth and the Northern Pacific Railway Co. and to provide channels within the harbor for vessels to reach the docks of Superior and Duluth. Dredging was to be carried to a depth of 13 feet below low-water datum.

The project adopted by the river and harbor act of March 3, 1881 (H. Doc. No. 82, 46th Cong., 2d sess.), provided for the maintenance of the harbors at Duluth and Superior City and the enlargement of the dredged areas and channels of these harbors by dredging to 16 feet below low-water datum. This work provided for the enlargement of Duluth Harbor by dredging as follows: On a line from Rices Point to Minnesota Point, on a line from the Blast Furnace docks to intersect with the channel of the St. Louis River, on a line parallel to Minnesota Point, and along the west side of Rices Point, in St. Louis Bay, all at an estimated cost of $187,988.36, with $25,000 for maintenance of canal piers, or a total of $212,988.36. (Annual Report for 1881, pp. 2028, 2029, 269; 1882, pp. 2103, 2104, 264.) For Superior City Harbor it included deepening the channel in the entry between the piers; dredging channel from the entry to a point beyond the mouth of the Nemadji River, around and parallel to the shore of Superior Bay to Quebec wharf, a distance of 8,400 feet; thence from the Quebec wharf along the west side of the bay to an intersection with the channel of the St. Louis River opposite Connors Point and up the Nemadji River for about one-half mile, the whole at a cost of $287,080, with $25,000 for pier maintenance, or an estimated total cost of $312,080. (Annual Report for 1881, pp. 2026–2029, 268, 269, 270; 1882, pp. 2095, 2096.) The river and harbor act of July 5, 1884, modified the project of 1881 by adding to the channels to be improved the channel of the St. Louis River within the Bay of Superior, increasing the cost of the improvement by $33,000, bringing the total estimated cost up to $345,080. (Annual Report for 1885, pp. 1945, 1959.)

The river and harbor act of August 5, 1886, further modified the project of 1881 by adding the improvement of St. Louis Bay, which provided for the dredging along the dock line on the Wisconsin shore from deep water at Connors Point toward deep water at Grassy Point. (Annual Report for 1887, p. 289.)

Digitized by Google

By the river and harbor act of August 11, 1888, the project of 1881 was still further modified by a provision of $28,000 for the extension of the new channel along Rices Point and $40,000 for a channel along the north shore of St. Louis Bay. (Annual Report for 1888, p. 1805.)

The river and harbor act of July 13, 1892, again modified the act of 1881 and authorized the expenditure of $45,000, or as much thereof as may be necessary, to be used in the discretion of the Secretary of War for improving the channel of St. Louis River above Grassy Point. (Annual Report for 1893, pp. 337, 2659; H. Doc. No. 58, 52d Cong., 1st sess.)

6. HARBOR AT ONTONAGON, MICH.

The previous project for the improvement of Ontonagon Harbor was based on a report and estimate submitted in 1867 and adopted by the river and harbor act of March 2, 1867. It contemplated the improvement of the mouth of Ontonagon River by the construction of two parallel timber-crib piers about 2,500 feet long and 250 feet apart, extending into the lake to the 18-foot curve of depth, and dredging a channel 12 feet deep at low water between them.

The estimated cost was $363,770.

The improvement was begun in 1867 and was considered completed in 1889. The west pier was built to a length of 2,675 feet and the east pier 2,315 feet. A channel 12 feet deep was dredged between the piers and through the bar in the lake. This channel filled up to a greater or less extent by freshets in the river and required frequent redredging. A total of 10,546 cubic yards for improvement and 302,452 cubic yards for maintenance was dredged prior to the adoption of the present project. This dredging was done to maintain a channel 100 feet wide and 12 feet deep through the bar in the lake and between the piers.

The total amount expended on the previous project was $284,801.24 for improvement and $113,326.76 for maintenance.

7. KEWEENAW WATERWAY, MICH.

The river and harbor act of September 19, 1890, provided as follows:

> For the purchase of the two canals known as the Portage Lake & River Improvement Co. Canal, from Keweenaw Bay to Portage Lake, and the Lake Superior Ship Canal Railway & Iron Co. Canal, from Portage Lake to Lake Superior, being the water communication across Keweenaw Point, Lake Superior, from Keweenaw Bay to Lake Superior, in the State of Michigan, by way of the Portage River and Lake and the artificial cut made by said companies to render them available to commerce and navigation, together with the works of improvement on Portage Lake; the harbor works upon Lake Superior and Keweenaw Bay, with all lands and franchises connected therewith, free from all incumbrances, $350,000: *Provided*, That for the purpose of preserving and continuing the use and navigation of said canals the sum of $10,000 for each of the present and the next fiscal year be appropriated, * * * or so much thereof as may be necessary, to pay the actual expenses of operating and keeping the said canals in repair * * *.

A valid title to all of said premises having been vested in the United States, and the State of Michigan having ceded the required jurisdiction over the same, the purchase money was paid to the said

Digitized by Google

companies and the United States assumed control of the canals August 3, 1891. (Annual Report for 1891, pp. 17, 18.)

The original project was based on a report of a board of engineers dated December 22, 1886. (Annual Report for 1887, p. 1977; H. Doc. No. 105, 49th Cong., 2d sess.) The project was adopted by the river and harbor act of September 19, 1890, and provided for (1) a 16-foot channel of 70-foot bottom width from bay to lake; (2) a renewal of the canal revetments; (3) a reconstruction of the piers at the Lake Superior entrance and their extension to 30-foot depth of water; (4) the extension of the pier at the Keweenaw entrance to 20-foot depth of water; (5) at the proper time hereafter to increase the channel depth to 20 feet, with a corresponding width, which should not be less than 120 feet. The river and harbor act of June 3, 1896, authorized the Secretary of War to enter into contracts for material and work to the extent of $1,065,000; not more than $400,000 of this, however, to be expended in any one fiscal year. (Annual Report for 1896, p. 2359.)

The full estimate for the project, including purchase and increase of depth to 20 feet with a width of 120 feet, $2,375,000, of which $350,000 was purchase money, leaving $2,025,000 as estimate for improvement. (H. Doc. No. 105, 49th Cong., 2d sess.; Annual Report for 1896, p. 2358.) Under date of March 15, 1898, the Chief of Engineers authorized the deepening of the channels to 20 feet and increasing their width to 120 feet. The entire project, including the change to the 20-foot depth and 120-foot width, was completed at a cost of only $45,000 in excess of the estimate for 16-foot depth and $715,000 less than the estimate for the 20-foot project.

10. HARBOR AT MARQUETTE, MICH.

The original project was based on an estimate by Maj. W. F. Raynolds, Corps of Engineers, made in 1866, for the construction of a breakwater composed of cribs filled with rock, and projecting from the shore into the bay a distance of 2,000 feet, at an estimated cost of $385,129.58.

It was adopted by the river and harbor act of March 2, 1867, and provided for the above construction at the same estimated cost. (H. Doc. No. 56, 39th Cong., 2d sess.; Annual Report for 1866, pp. 8, 77.) Work was commenced in August, 1867, and 2,010 linear feet had been completed in 1875. (Annual Report for 1875, pp. 2 and 11.) The river and harbor act of August 11, 1888, provided for the further extension of 1,000 linear feet to the breakwater, at an estimated cost of $121,000. (Annual Report for 1889, pp. 272, 2021.) This extension differed from the portion previously constructed in that it provided a foundation of rubble stone to support the cribs. Work was commenced on the 1,000-foot extension in July, 1889. (Annual Report for 1890, pp. 245, 2300.) The extension was prosecuted under succeeding appropriations and completed in 1894.

A plan for a concrete superstructure to cover 2,000 linear feet of the breakwater, at an estimated cost of $149,454.36, was approved by the Chief of Engineers February 27, 1890. (Annual Report for 1890, pp. 245, 2301.) This estimate was increased in 1891 to $232,936.71, to cover 3,000 feet of breakwater. (Annual Report for 1891, pp. 315, 2506.) Work on the concrete superstructure was commenced in 1895 and completed to a length of 2,920 feet in 1905. (Annual Report for

Digitized by Google

1906, pp. 574, 1726.) For detailed description of the concrete work, with drawings, photographic views, costs, etc., see Annual Reports for 1896, pages 2365 to 2385; 1897, pages 2615 to 2638; 1898, pages 2252 to 2282. The Annual Report for 1904, pages 2775 and 2776, describes the cross section of the latest portion of the work.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE MILWAUKEE, WIS., DISTRICT.

---

1. MANISTIQUE HARBOR, MICH.

The first survey of the mouth of the Manistique River with a view to its improvement by the United States was made in 1873. (Annual Report for 1873, p. 254.) A plan and estimate was submitted, but no appropriation was made. In 1879 an examination of this locality was made. (Annual Report for 1880, p. 1931.) It was found that since the survey of 1873 local interests had constructed piers at the mouth of the river and had done some dredging. As a result of this examination an appropriation was made, and a small amount of dredging was done by the United States in 1880, when operations were suspended until 1909. About 1883 private parties built a timber-crib breakwater about 420 feet long, protecting the mouth of the river.

The original project, adopted by river and harbor act of June 14, 1880, provided for increasing the depth of channel to 13 feet below mean lake level, 1860–1875, for a width of 150 feet. The length of channel was not stated. There was no modification of the original project.

2. MENOMINEE HARBOR AND RIVER, MICH. AND WIS.

The first survey at the mouth of the Menominee River with a view to its improvement by the United States was made in 1867. (Annual Report for 1867, p. 132.) The improvement was begun in 1871, and until 1890 was confined to pier construction and dredging at the mouth of the river. The improvement of the river above its mouth was begun in 1890, and consisted entirely of dredging.

The harbor and river, which originally constituted separate works, were consolidated by the river and harbor act of June 13, 1902.

Harbor.—The original project was adopted by river and harbor act of March 3, 1871, and provided for two parallel piers 400 feet apart, the north pier to be about 1,550 feet long and the south pier about 1,950 feet long, and for a channel between the piers 15 feet deep below mean lake level, 1860–1875.

This project was modified by river and harbor act of September 19, 1890, increasing the depth of channel to 17 feet, and again modified by river and harbor act of March 3, 1899, increasing the depth to 20 feet below mean lake level, 1860–1875. (H. Doc. No. 86, 54th Cong., 2d sess.)

River.—The original project was adopted by river and harbor act of September 19, 1890 (H. Doc. No. 34, 51st Cong., 1st sess.), and

Digitized by Google

provided for a channel 17 feet deep below mean lake level, 1860–1875, 200 feet wide, and extending "up the river from termination of old work" to N. Ludington & Co.'s mill, a distance of about 8,675 feet.

This project was modified by river and harbor act of July 13, 1892, reducing the width of the upper 2,600 feet of the channel to 100 feet. (Annual Report for 1891, p. 2529.) It was again modified by river and harbor act of June 3, 1896, increasing width of channel at upper end to 250 feet for a distance of 600 feet, forming a turning basin and extending the main channel, as it then existed, a distance of 425 feet to the west line of Wells Street, with a width of 75 feet; the depths in turning basin and channel extension to be 17 feet below mean lake level, 1860–1875.

3. OCONTO HARBOR, WIS.

The first survey at the mouth of the Oconto River with a view to its improvement by the United States was made in 1870. A plan and estimate based on this survey was submitted, but no appropriation was made. (Annual Report for 1871, p. 120.) In 1879 an examination of this locality was made and another plan and estimate submitted. (Annual Report for 1880, p. 1973.) Prior to beginning the improvement by the United States the city of Oconto built two parallel piers at the mouth of the river, the north pier 400 feet long, and the south pier 600 feet long, and did a small amount of dredging.

The first appropriation for the improvement of this harbor was made by river and harbor act of March 3, 1881, for the purpose of aiding the city in the work it had already begun.

The original project for improvement by the United States was adopted by river and harbor act of August 2, 1882, and provided for extending the piers built by the city to the 11-foot contour in Green Bay, the extension to north pier being about 1,200 feet, and that to the south pier about 1,500 feet, and for a channel 100 feet wide and 9 feet deep below mean lake level, 1860–1875, extending up the river a distance of about 2 miles. A modification of this project, approved by the Chief of Engineers March 11, 1897, provided for abandoning the upper 3,800 feet of the river channel.

4. GREEN BAY HARBOR, WIS.

No improvement of this harbor was undertaken prior to beginning same by the United States in 1866.

The original project, adopted by river and harbor act of June 23, 1866, provided for a channel 200 feet wide and 12 feet deep, extending from the mouth of Fox River northerly in Green Bay, a distance of about 8,800 feet, and for the protection of the cut through Grassy Island by revetments. This project was modified by river and harbor act of June 23, 1874, increasing the depth to 15 feet and the length of channel to 11,600 feet. It was again modified by river and harbor act of July 13, 1892, increasing the depth to 17 feet and length to 16,500 feet, and providing for a channel 150 feet wide and 13 feet deep below mean lake level, 1860–1875, in the Fox River

Digitized by Google

between the cities of Green Bay and Depere. The project was again modified by river and harbor act of June 3, 1896, increasing depth in channel between Green Bay and Depere to 17 feet. A further modification, approved by the Chief of Engineers March 9, 1897, provided for increasing width of channel in Green Bay at the outer or northerly end to 500 feet.

6. STURGEON BAY AND LAKE MICHIGAN SHIP CANAL, WIS.

By an act of April 10, 1866, 200,000 acres of the public lands were "granted to the State of Wisconsin for the purpose of aiding said State in constructing and completing a breakwater and harbor and a ship canal to connect the waters of Green Bay with the waters of Lake Michigan." In 1871 a survey was made by the United States and plans and estimates prepared for the construction of the canal. (Annual Report for 1872, p. 171.) The Sturgeon Bay & Lake Michigan Ship Canal & Harbor Co., chartered by the State of Wisconsin, between 1872 and 1881, constructed a canal without locks or gates 7,200 feet long, 100 feet wide at water surface, and 14 feet deep below mean lake level, 1860–1875, and in continuation of the canal dredged a channel in Sturgeon Bay 6,100 feet long, of about the same dimensions as the canal. Protection works, constituting what was known as the "Harbor of refuge," at the Lake Michigan entrance to the canal were constructed by the United States, such work having begun in 1873. The river and harbor act of July 13, 1892, provided for the acquisition of the canal by the United States, pursuant to which the United States assumed control on April 25, 1893.

Prior to the river and harbor act of June 13, 1902, the canal and harbor of refuge connected therewith constituted two works. By this act they were consolidated.

Harbor.—The original project, adopted by river and harbor act of March 3, 1873, provided for the construction of converging piers, each about 1,200 feet long, 850 feet apart at the shore line, and 250 feet apart at outer end, inclosing an area of about 10 acres; the inclosed basin, or so much as necessary for requirements of navigation, was to be dredged to a depth of 13 feet below mean lake level, 1860–1875. This project was modified by river and harbor act of June 14, 1880, providing for extending each pier 150 feet by detached cribs, increasing width of entrance to 335 feet, and increasing the depth of channel to 17 feet.

Canal.—The original project, adopted by river and harbor act of August 18, 1894, provided for increasing width of canal to 160 feet, and for a channel 15 feet deep below mean lake level, 1860–1875. This project was modified by river and harbor act of June 3, 1896, increasing width of westerly 1,000 feet of the canal to 250 feet.

7. ALGOMA HARBOR, WIS.

This harbor was originally called Ahnapee. The first survey with a view to its improvement by the United States was made in 1870. (Annual Report for 1871, p. 125.)

The original project adopted by river and harbor act of March 3, 1871, provided for the formation of an outer harbor or basin cover-

Digitized by Google

ing the mouth of the Ahnapee River by breakwater construction and dredging, the area of inclosed basin to be about 60 acres; the depth to be obtained is not known. This project was modified by subsequent river and harbor acts as follows: March 3, 1873, providing for a small harbor at the mouth of the river by constructing parallel piers and dredging between them; March 3, 1875, providing for an extension of the piers to the 18-foot contour in Lake Michigan and the formation of a small inner harbor in the river 100 feet wide and 13 feet deep below mean lake level, 1860–1875, extending from the highway bridge to the mouth of the river, a distance of about 1,000 feet; July 5, 1884, providing for extending the piers in Lake Michigan and increasing width of entrance to 200 feet; March 3, 1899, providing for extending the 13-foot channel up the river for a distance of 800 feet above the highway bridge, the width of the extension to be 50 feet.

8. KEWAUNEE HARBOR, WIS.

The first survey of the mouth of the Kewaunee River with a view to its improvement by the United States was made in 1836; a plan of improvement and estimate of cost were prepared. (S. Doc. No. 175, 25th Cong., 2d sess.) In 1873 another survey was made in accordance with river and harbor act of March 3, 1873. (Annual Report for 1873, p. 258.) A third survey was made in 1880 in accordance with river and harbor act of June 14, 1880. (Annual Report for 1881, p. 2082.) In the meantime local authorities had raised $8,000 for harbor purposes, none of which had been expended.

The original project was adopted by river and harbor act of March 3, 1881, and provided for an artificial entrance channel 15 feet deep below mean lake level, 1860–1875, located about 2,000 feet south of the river mouth, protected by two parallel piers 200 feet apart, and each 1,650 feet long, extending from the shore to the 19-foot contour in Lake Michigan. There was no modification of this project prior to the adoption of the existing project.

On June 1, 1881, the Government entered into contract for the construction of 500 linear feet of pile pier. Payments to the extent of $8,042.72 on materials and labor used under this contract were made by the Kewaunee harbor commissioners, the balance being paid by the United States. (Annual Report for 1882, p. 2141.)

9. TWO RIVERS HARBOR, WIS.

The first survey of this harbor with a view to its improvement by the United States was made in 1870. (Annual Report for 1871, p. 111.)

The original project adopted by river and harbor act of March 3, 1871, provided for the formation of channel of navigable width and 13 feet deep below mean lake level, 1860–1875, connecting Twin Rivers and Lake Michigan, the channel to be protected by parallel piers, 260 feet apart, and about 1,750 feet long, extending to the 19-foot contour in Lake Michigan. A modification of this project, providing for terminating the piers at the 14-foot contour, was approved by the Chief of Engineers February 27, 1897.

Digitized by Google

10. MANITOWOC HARBOR, WIS.

The first survey at the mouth of the Manitowoc River with a view to its improvement by the United States was made in 1836. A plan and estimate for construction of piers was submitted in 1838. (S. Doc. No. 175, 25th Cong., 2d sess.) No further action was taken until Congress appropriated $8,000 by river and harbor act of August 30, 1852, for the improvement of this harbor. A second survey was made in 1853 and another plan and estimate prepared and submitted.

The original project was adopted in 1854, based upon the last plan and estimate; the month and day when the project was formally adopted is unknown. This project provided for building parallel piers 220 feet apart, the length of the north pier to be about 1,050 feet and of the south pier about 950 feet, and for dredging between the piers to obtain a channel 12 feet deep. This project was subsequently modified by river and harbor acts as follows: March 3, 1881, the depth at entrance was increased to 19 feet, and at the shore line to 15 feet below mean lake level, 1860–1875, and the piers were extended to the 19½-foot contour; September 19, 1890, provided for an exterior breakwater 400 feet long and 24 feet wide; June 3, 1896, provided for increasing the depth of channel throughout to 20 feet below mean lake level, and for extending south pier 500 feet (H. Doc. No. 300, 54th Cong., 1st sess.); June 13, 1902, provided for extending the breakwater lakeward 400 feet (H. Doc. No. 233, 56th Cong., 1st sess.).

11. SHEBOYGAN HARBOR, WIS.

The first survey at the mouth of the Sheboygan River with a view to its improvement by the United States was made in 1836. A plan and estimate for the construction of piers and dredging were submitted in 1838. (S. Doc. No. 175, 25th Cong., 2d sess., p. 10.) No further action was taken until Congress appropriated $10,000 by river and harbor act of August 30, 1852, for the improvement of this harbor. This appropriation, together with $55,000 raised by the city and county of Sheboygan, 1852–1860, was expended by the local authorities in pier construction and dredging to a depth of 12 feet.

The original project, adopted by river and harbor act of June 23, 1866, provided for extending the piers built by local authorities 120 feet on the north and 320 feet on the south pier, and for dredging between the piers to obtain a channel 13 feet deep below mean lake level, 1860–1875. This project was subsequently modified by river and harbor acts as follows: March 3, 1873, the channel depth was increased to 17 feet below mean lake level; March 3, 1881, providing for extending the piers to the 21-foot contour, and increasing depth at entrance to 19 feet, diminishing to 15 feet at the shore line; August 18, 1894, providing for increasing the width between the piers and for a channel 19 feet deep throughout; March 3, 1899, providing for an exterior breakwater 700 feet long on north side of entrance (H. Doc. No. 53, 55th Cong., 3d sess.); June 13, 1902, providing for extending the north pier 200 feet, and the south pier 600 feet, and for a channel 21 feet deep (H. Doc. No. 327, 54th Cong., 2d sess.).

Digitized by Google

12. PORT WASHINGTON HARBOR, WIS.

At an early but unknown date a survey was made at the mouth of the Sauk River and a plan of improvement was submitted to the Board of United States Engineers for building two parallel piers 200 feet apart and for a basin 600 feet long and 200 feet wide inside the shore line. Nothing further was done toward the improvement of this harbor until 1869, when a survey was made pursuant to a resolution of the Committee of Commerce of the House of Representatives and a plan of improvement with estimate of cost was submitted. (Annual Report for 1870, p. 119.)

The original project was adopted by river and harbor act of July 11, 1870, and provided for a channel 13 feet deep below mean lake level, 1860–1875, between parallel piers, 150 feet apart, and for a basin 600 feet long, 200 feet wide inside the shore line. This project was modified by the river and harbor act of August 14, 1876, providing for a second basin to the northward and nearly at right angles to the first basin of practically the same dimensions as the west basin.

13. MILWAUKEE HARBOR, WIS., INCLUDING HARBOR OF REFUGE.

The first survey of this harbor with a view to its improvement by the United States was made in 1836. A plan and estimate for the construction of piers and dredging were submitted in 1838. (S. Doc. No. 175, 25th Cong., 2d sess.) No further action was taken until Congress appropriated $30,000 by act of March 3, 1843.

The first survey of Milwaukee Bay with a view to the creation of a harbor of refuge was made in 1880, pursuant to an item in river and harbor act of June 14, 1880, which reads: "Improving the bayou south of Milwaukee Harbor for additional purposes of a harbor of refuge at Milwaukee; also, Milwaukee Bay." Plans and estimates were prepared and reviewed by a board of engineers. (Annual Report for 1881, p. 2116.)

Milwaukee Harbor and the harbor of refuge, which were originally separate works, were consolidated by the act of June 13, 1902.

Harbor.—The original project for the improvement of Milwaukee Harbor, adopted by act of March 3, 1843, provided for dredging at the original river mouth to a depth of 12 feet and protecting the entrance by parallel piers 260 feet apart. This project was modified by the river and harbor act of August 30, 1852, which provided for the formation of a channel 260 feet wide and 13 feet deep below mean lake level, 1860–1875, located 3,000 feet to the northward of original mouth of the Milwaukee River, by dredging across the overlapping point and protecting the channel by parallel piers, each 1,120 feet long. The project, as modified, was carried out mainly by the city of Milwaukee, which, between 1852 and 1870, expended $445,971.20 on account of the harbor. The project was again modified by river and harbor act of April 10, 1869, which provided for extending each pier 600 feet. A modification adopted by the river and harbor act of March 3, 1899, provided for deepening the channel to 21 feet below mean lake level, 1860–1875. (H. Doc. No. 61, 54th Cong., 2d sess.)

Harbor of refuge.—The original project for the harbor of refuge was adopted by the river and harbor act of March 3, 1881, and provided for a breakwater 7,650 feet long, including an opening therein

Digitized by Google

of 400 feet. This project was modified June 29, 1893, by authority of the Secretary of War, to provide for the deposit of riprap along the sides of the breakwater wherever necessary. (See Annual Report for 1894, p. 2082.)

The river and harbor acts of June 13, 1902, and March 3, 1905, provided for building concrete superstructure on the north harbor pier and on 3,450 feet of the northern end of the breakwater.

15. RACINE HARBOR, WIS.

The first survey at the mouth of the Root River with a view to its improvement by the United States was made in 1836, and plans and estimates of cost of the improvement were prepared. (S. Doc. No. 175, 25th Cong., 2d sess., p. 5.) No appropriation for the improvement of this harbor was made until by special act of June 15, 1844, $12,500 was appropriated "to aid in the completion of a harbor already commenced by the citizens of the town of Racine, at the mouth of Root River, in the Territory of Wisconsin."

The original project, adopted by the citizens in 1842–43, provided for a channel 12 feet deep between parallel piers 160 feet apart. This project was modified by river and harbor act of June 23, 1866, which provided for increasing the depth to 16 feet and for extension of piers. The project was further modified by the river and harbor act of March 3, 1899, which provided for widening the channel and increasing depth to 21 feet below mean lake level, 1860–1875, for extending the south pier 300 feet, and for a breakwater 600 feet long. (H. Doc. No. 326, 54th Cong., 2d sess., and H. Doc. No. 165, 55th Cong., 3d sess.) The river and harbor act of June 13, 1902, provided for change in the location and direction of the breakwater.

16. KENOSHA HARBOR, WIS.

The first survey of the harbor of Southport, now Kenosha, Wis., with a view to its improvement by the United States, was made in 1837, and a plan and estimate were prepared. (S. Doc. No. 103, 25th Cong., 2d sess., p. 18.) An act approved June 15, 1844, appropriated $12,500 "for the construction of a harbor at the town of Southport, in the Territory of Wisconsin." An act approved March 3, 1845, appropriated the further sum of $15,000 "for the purpose of aiding in the completion of the harbor already commenced at the town of Southport, in the Territory of Wisconsin." There is no available record of what improvements were made, or by whom, with these appropriations.

The original project for the improvement of this harbor, so far as can be determined from available records, was adopted by river and harbor act of August 30, 1852, and provided for a channel 12 feet deep between parallel piers 150 feet apart. This project was modified by subsequent river and harbor acts as follows: June 23, 1866, provided for a navigable channel 16 feet deep; September 19, 1890, provided for dredging in "The Basin," being the inner harbor; March 3, 1899, provided for extending the south pier 525 feet, for increasing the width between the piers to 250 feet by rebuilding the north pier, for a breakwater 600 feet long, and for increasing the depths in channel and basin to 21 feet and 20 feet, respectively, be-

Digitized by Google

low mean lake level, 1860–1875. (H. Doc. No. 328, 54th Cong., 2d sess., and H. Doc. No. 164, 55th Cong., 3d sess.); June 13, 1902, provided for extending the breakwater 100 feet shoreward.

17. WAUKEGAN HARBOR, ILL.

The river and harbor act of August 30, 1852, appropriated $15,000 "for the improvement of the harbor and breakwater at Waukegan, Ill." A survey was made in 1855, and one crib 30 feet long and 25 feet wide was placed in line of the proposed breakwater. This crib was later carried away during a storm and further work was abandoned. In 1872 a survey was made and plan and estimates prepared for an outer harbor. (Annual Report for 1873, p. 247.) Another survey was made in 1879 and a further plan and estimate prepared. (Annual Report for 1880, p. 1942.)

The original project, adopted by river and harbor act of June 14, 1880, provided for an artificial harbor of sufficient capacity for local trade by inclosing an area of about 16 acres with pile piers, the depth in entrance channel and inclosed area to be 13 feet below mean lake level, 1860–1875. This project was modified by river and harbor act of August 2, 1882, which provided for moving the harbor entrance about 1,200 feet north of the originally proposed entrance and reducing the area of the inclosed basin to about 10 acres. (Annual Report for 1882, pp. 277, 2163.)

18. FOX RIVER, WIS.

By an act of Congress, dated August 8, 1846 (chap. 170), the United States granted to the State of Wisconsin, upon its admission into the Union, a large quantity of land for the purpose of improving the navigation on the Fox and Wisconsin Rivers, and constructing a canal to unite those rivers at or near the portage, the purpose being to create a great water highway from the Great Lakes to the seaboard. To carry out the object of this act, the State, by acts of its legislature, dated June 29 and August 8, 1848, accepted the grant and established a board of public works to carry on the work of improvement.

The State of Wisconsin, by act of the legislature of July 6, 1853, incorporated the Fox & Wisconsin Improvement Co. and transferred the rights and obligations of the State in the land grant to the company. This company failing to accomplish much, the State, by act of its legislature dated October 3, 1856, placed the sale of the lands and the entire improvement in the hands of a board of trustees, who, in 1863, filed a bill of complaint and, on February 4, 1864, judgment of foreclosure was entered. On August 15, 1866, the property was sold to the Green Bay & Mississippi Canal Co.

The State of Wisconsin, by act of March 23, 1871, authorized the Green Bay & Mississippi Canal Co. to sell and dispose of its rights and property to the United States. At that time the entire improvement was valued at $1,048,070, from which was deducted $723,070, the estimated amount received from the sale of lands, leaving a balance of $325,000 to be paid to the canal company. The Secretary of War determined that the personal property, appraised at $40,000,

Digitized by Google

and the franchises of the corporation, including the water powers, appraised at $140,000, were not required for the purposes of navigation and were deducted from the above amount, leaving a balance of $145,000. This amount was appropriated by the river and harbor act of June 10, 1872, and paid to the canal company.

At the time of the transfer, with the exception of one stone lock, the structures were all temporary and in bad condition. The first project of the State contemplated the construction of canals 40 feet wide at bottom with 4 feet depth at usual low water, and locks 125 feet long between gates and 30 feet wide in the chamber. The plans of the Fox & Wisconsin Improvement Co. increased the length of the locks to 160 feet, the width to 35 feet, and the depth to 5 feet on the miter sills.

The original project for the improvement of the Fox and Wisconsin Rivers was adopted by the river and harbor act of March 3, 1873. The general plan adopted was: (1) the repair and replacing of existing works on Fox River, (2) the construction of additional locks and dams to complete the system of slackwater navigation on the upper Fox, (3) the deepening and widening of channels in the various levels, (4) the completion of the improvement of the Wisconsin River by contracting and fixing the low-water channel; and, finally, the replacing of all the existing locks and dams by permanent work. (Annual Report for 1873, p. 36.)

The improvement of the Wisconsin River, consisting in the construction of wing dams, dikes, and snagging, was abandoned in 1887, upon the recommendation of a board of engineers. (Annual Report for 1887, p. 2094.)

Questions having arisen relative to the property rights, rights of way, etc., transferred by the Green Bay & Mississippi Canal Co. to the United States by deed of 1872, the river and harbor act of June 3, 1896, provided "for a thorough investigation of the character, limitations, and description of the property rights of the United States." Such investigation was made by the Hon. Edward S. Bragg, and report, dated February 15, 1898, submitted to the Secretary of War. (H. Doc. 389, 55th Cong., 2d sess.)

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE CHICAGO, ILL., DISTRICT.

---

1. CHICAGO HARBOR, ILL.

The first work of improvement by the Government was in accordance with act of March 2, 1833, and consisted of cutting and revetting with piers a new mouth of Chicago River from a point near old Fort Dearborn, where the river approached the shore and turned southward. The piers have been extended from time to time and the channel maintained by dredging.

While it is known that the cut mentioned and the construction of 2,614.5 feet of north pier and 719.5 feet of south pier were accom-

Digitized by Google

plished between 1833 and 1840 (inclusive) with funds appropriated by acts of March 2, 1833; June 28, 1834; March 3, 1835; July 2, 1836; March 3, 1837; and July 7, 1838, no data are available definitely to connect the main or modified projects with any particular one of these various acts. During 1852, with funds appropriated by act of August 30, 1852, a pierhead 170 feet long was built at the outer extremity of the north pier. In 1864 the city of Chicago furnished the sum of $75,000 which was expended in dredging and in extending the north pier 450 feet, giving it a total length at that time of 3,234.5 feet. From 1866 to 1869, inclusive, and with funds appropriated by acts of June 23, 1866; July 25, 1868; and April 10, 1869, the north pier was extended 400 feet beyond the gap of 315 feet made by the entrance to Ogden Slip, thus completing 3,634.5 feet of north pier work; and 1,148 feet was added to the south pier, making a total of 1,867.5 feet of completed work in that pier.

Ogden Slip above referred to was constructed in 1861 by the Chicago Canal & Dock Co. with permission of the War Department. Likewise, Slip A, 175 feet; Slip B, 160 feet; and Slip C, 167 feet wide, respectively, were constructed through the south pier in 1864 and 1865 by the Illinois Central Railroad Co.

Dredging to maintain an average depth of 14 feet was carried on intermittently from 1833 to 1870. The amount appropriated and expended by the United States, 1833 to 1869 (inclusive), was $446,005.

For a more voluminous and detailed history of this improvement from 1833 to 1869, inclusive, see pages 433–438, part 2, of Annual Report for 1876.

2. CHICAGO RIVER, ILL.

The original project, adopted by Congress in the act of June 3, 1896, provided for 16 feet draft throughout this river, at an estimated cost of $700,000. Under this project 17 feet actual depth was secured throughout the navigable sections of the river, obstructive projections of land in the river were removed, and docks built in places to protect new channel.

The act of June 13, 1902, added to the project a provision for two turning basins (one in the North Branch and one in the South Branch), to be dredged to a depth of 21 feet, at an estimated cost of $500,000, making the total estimated cost of the original project thus modified $1,200,000.

There has been expended on previous projects $1,065,348.42, of which $109,462.55 was for maintenance.

Except for a small amount of rock revetment about the turning basin, since constructed, the original project was completed before the adoption of the existing project.

A brief history of river and harbor improvement at Chicago prior to 1876 is given on pages 433–438, part 2, Annual Report for 1876, and a very full description of present conditions is to be found on pages 186–198, Bulletin No. 24 (1915), issued by the United States Lake Survey Office, Detroit, Mich. For maps of river and turning basins, see pages 1892–1893, Annual Report, 1903.

For general description of the sanitary district projects, see page 2097, Annual Report for 1902.

Digitized by Google

3. CALUMET HARBOR, ILL.

The earliest Government surveys of this harbor were made in 1836, 1845, and 1869, and actual work of improvement was later undertaken in accordance with act of July 11, 1870, which called for a "harbor of refuge," the idea being to afford "relief needed by the crowded commerce of Chicago," by furnishing "a safe and practicable entrance to Calumet River and the port of South Chicago."

With this end in view a beginning was made by cutting through the 400-foot wide bar at the point where the river turned south (near the present U. S. Coast Guard station) and by constructing parallel piers on the north and south side of the river in order to give a straight outlet into the lake.

Under the project adopted by act of July 11, 1870, as modified by act of August 11, 1888, and covering the period from 1870 to 1895, inclusive, 3,640 linear feet of north pier and 2,020 linear feet of south pier were constructed, and a channel 16 feet deep (Chicago city datum) and 200 feet wide dredged between them. The amount expended by the United States, 1870–1895 (inclusive), was $454,484.53.

For a more detailed history of the early work of this improvement see pages 441–444, part 2, of Annual Report for 1876.

4. CALUMET RIVER, ILL. AND IND.

The project for the improvement of this river, adopted by Congress in 1884 and modified in 1886, contemplated securing a channel 200 feet in width and 16 feet in depth from the mouth of the river at Calumet Harbor, Ill., about 11 miles upward, to a point one-half mile east of Hammond, Ind. This project was modified by act of June 3, 1896, for Calumet Harbor, so as to provide for dredging the channel to 20 feet navigable depth from the mouth 2 miles upward.

The projects of 1884 to 1896, now terminated, secured a channel of 200 feet width and 22 feet actual depth from the mouth of the river about 2 miles upstream (including a small turning basin near the mouth of the river); thence a channel 16 feet deep and 200 feet wide about 3 miles farther, except over short portions where rock reduced the width to 85 feet and the depth to 14 feet; and thence a temporary channel 10 feet deep and 60 feet wide for the next 6 miles, up to a point on the Grand Calumet one-half mile east of Hammond, Ind.

There has been expended on previous projects $446,718.98, including $45,230.48 for maintenance.

For a more detailed history of the earliest work on this improvement see pages 441–444, part 2, of Annual Report for 1876.

5. INDIANA HARBOR, IND.

The original project, included in the existing project, was adopted in act of June 25, 1910, based on recommendations in House Document No. 1113, Sixtieth Congress, second session (without map), and embraced the following:

(1) Completion and maintenance of channel in outer harbor, 300 feet wide and 22 feet deep, including an entrance channel increasing gradually in width and depth from pier ends to lake.

Digitized by Google

(2) Maintenance of inner harbor channel, 200 feet wide and 20 feet deep, extending from the outer harbor to the Grand Calumet River (about 3.5 miles) and to Lake George (length of branch, 1.5 miles), this maintenance to be undertaken as fast as the channel is dredged by private interests and bridges are provided with proper draw openings.

Interpretations made by this office and by the Chief of Engineers require that the inner harbor channel, prior to acceptance for maintenance, shall be 200 feet wide at the surface and 20 feet deep below Chicago city datum throughout a center width of at least 80 feet, the channel thereafter to be maintained to be limited to that dredged by and accepted from private interests.

The estimated cost of this work was $62,000. No estimate of the annual cost of maintenance of the inner harbor has ever been submitted, but it was originally estimated that the annual cost of maintaining the outer harbor and entrance channel would be $5,000.

The work of the original project (except maintenance) has been completed.

Under the above project 234,363 cubic yards of material was removed from the outer and inner harbors, resulting in completing both channels to project dimensions as far as the first obstructing railroad bridge. The amount expended on this work was $63,176.95, of which $2,509.54 was for maintenance.

The work of the original project (except maintenance) has been completed.

For a more detailed history of the work on this improvement see pages 201–203, Bulletin No. 24 (1914), issued by the U. S. Lake Survey office, Detroit, Mich.

6. MICHIGAN CITY HARBOR, IND.

The work of improvement of this harbor was commenced by the Government in accordance with act of July 3, 1836, and work up to 1866 (with funds appropriated by the subsequent acts of Mar. 3, 1837, July 7, 1838, June 11, 1844, Aug. 30, 1852, and Mar. 2, 1855) had been limited to confining the channel at the outlet of Trail Creek by east and west piers 1,135 and 994 feet long, respectively, with a channel 100 feet wide and 12 feet deep between.

In accordance with conditions imposed by act of March 2, 1867, $100,526.03 was expended by the Michigan City Harbor Co. "in the construction of a safe and convenient harbor," but the details of the work done by this company are not available.

In 1868 and 1869, 96 feet were added by the United States to the east and 256 feet to the west pier, and during the next season (1869–1870) the east pier was further extended 46 feet and the west pier 242 feet, which brought the ends of both piers to rest in 12 feet depth of water, and gave them a total length at that time of 1,277 and 1,492 feet, respectively.

Dredging was carried on intermittently during the period 1836–1870, but the full amount of work done by either the Government or Michigan City Harbor Co. is not known. It is known, however, that 158,999 cubic yards of material was dredged by the United States from the inner harbor from 1866 to 1869, inclusive.

Digitized by Google

A brief history of this improvement is given on pages 678–680, Annual Report for 1908. (See also pp. 447–451, Annual Report for 1876.)

7. ILLINOIS RIVER, ILL.

The original project for the improvement of this river, adopted by Congress in the act of August 30, 1852, provided for "the improvement of the navigation of the Illinois River" by dredging. Cost figures not available.

The act of April 10, 1869, adopted the plan of slack-water navigation from La Salle to the mouth by means of locks and dams, at a cost of "something less than two million dollars."

The act of July 11, 1870, added to the project a provision for "dredging an open channel 150 feet wide and 4 feet deep at low water," and building "catchment and wing dams where necessary * * * until the means for slack-water navigation are fully or nearly furnished," at an estimated cost of $392,000.

There resulted from the above projects, now terminated, "channels having not less than 4 feet depth through the worst bars, the aggregate length of dredged channels being about 24 miles; for maintaining these channels and contracting the waterway, about 12,000 linear feet of brush and stone dams were built, and a valuable outfit for carrying on this work and the work of dredging had been procured. Cooperating with the General Government, the State of Illinois built two locks and dams (Henry and Copperas Creek), at a cost of $747,747, which gave a depth of 7 feet for a distance of 90 miles below La Salle, the river terminus of the Illinois and Michigan Canal."

There has been expended on these previous projects $550,450.55.

For a more detailed history of the earliest work on this improvement, see pages 1572–1580 of Annual Report for 1879.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE GRAND RAPIDS, MICH., DISTRICT.

---

1. (A) ST. JOSEPH HARBOR, MICH.

The original project was adopted by the river and harbor act approved July 4, 1836, as follows: "For the construction of a pier or breakwater at the mouth of the river St. Joseph, $20,000."

Up to 1863 there had been built a north pier about 1,100 feet and a south pier about 212 feet long, with a width between piers of 240 feet and a depth (datum not stated) of 12 feet at the entrance and 9 feet in the inside basin. These piers protected a cut through the narrow tongue of land north of the old river mouth. The river before entering into Lake Michigan spread into a basin 800 feet wide in front of the town of St. Joseph, with two distinct channels, one on the north side, formed by the water from the Paw Paw River, and the other on the south side, being the channel proper of the St. Joseph River. (Annual Report for 1876, p. 519.)

Digitized by Google

The project adopted by the river and harbor act approved June 23, 1866, provided for the extension of the south pier in the same direction 200 feet into the lake; repairs to 409 feet of the north pier and 200 feet of the south pier; all at an estimated cost of $28,459.84. The pier extension was to be built of piles cut off at water surface, with a superstructure of cribwork, the whole to be filled with slabs or brush and ballasted with stone. The pier repairs were to the portions above water surface. (Annual Report for 1866, p. 111, and for 1876, p. 520.) The repairs were made and the 200-foot extension to the south pier was completed in 1868.

In 1867 the Chief of Engineers (Annual Report for 1867, p. 24) recommended the extension of the south pier 700 feet, at an estimated cost of $77,000. This project was adopted by the river and harbor act approved July 11, 1870, which appropriated $15,000. Under this project an extension of 416 feet to the south pier was completed in 1871, making its total length 819 feet, the north pier being 1,070 feet long at this time.

The river and harbor act approved March 3, 1875, amended the project to include an extension of the north pier 400 feet in a direction north 78° west, at an estimated cost of $42,215.47; also for a wing dam on the north side, at the mouth of Paw Paw River. (H. Ex. Doc. No. 160, 43d Cong., 2d sess., and Annual Report for 1875, pp. 6 and 28.)

In 1875, 528 feet of wing dam was constructed in the river, to deflect the current and deepen the channel to the mouth of the Benton Harbor Canal, to which dam a row of piles was added in 1876, prolonging the dam 194 feet. The cost was $9,046.24. (Annual Report for 1876, p. 103.) The north pier was extended 300 feet in 1875, 50 feet in 1879, and 100 feet in 1880 and 1881.

The project was amended by the river and harbor act approved June 14, 1880, to include the channel leading up to the city of Benton Harbor. The work proposed was: To dredge the canal to a depth of 12 feet for a width of 80 feet; to revet the north bank a distance of about 3,000 feet; all at an estimated cost of $20,000. (Annual Report for 1880, pp. 2030, 2031, and 2049 to 2055.)

The width of the canal was increased to 100 feet by the river and harbor act approved August 2, 1882. (Annual Report for 1882, p. 2320.)

In 1889 the north pier was secured by connection to the shore by pilework filled with brush.

The river and harbor act approved July 13, 1892, adopted a project which provided for rebuilding 373 feet of north pier crib work, for refilling north revetment, minor repairs, repairing wing wall, and additional dredging, all at an estimated cost of $25,000; also for extension of the north pier 1,200 feet at an estimated cost of $120,000; a total of $145,000. This made the original estimated cost, as here revised, $519,113. (Annual Report for 1892, p. 2358, 2360, and 2362–2363.) The object sought by this project was an entrance channel 270 feet wide and 16 feet deep, the extension of the same depth in the harbor, and an interior navigation 13 feet deep from there to Benton Harbor, nearly 1 mile above. (Annual Report for 1894, p. 339.) In December, 1892, a contract was entered into for extending the north pier 350 feet (Annual Report for 1893, p. 369), which was accom-

Digitized by Google

plished in 1893. The remaining 850 feet was not built under this project.

June 30, 1894, the north pier and revetment was 2,013.5 feet long, and projected 1,300 feet beyond the shore line. It comprised 831.5 feet of pile work and 1,182 feet of crib work. The south pier was 819 feet long, projecting 550 feet beyond the shore line. The actual channel depths at this time were generally 14 to 15 feet.

2. SOUTH HAVEN HARBOR, MICH.

The original project provided for two parallel piers 120 feet apart, in a direction south 84° 30′ west from the mouth of the river, into 12 feet of water in the lake, the north pier to be a prolongation of the existing north pier, as follows: Extension of north pier 512 feet and of south pier 576 feet, 1,088 feet of pier work; 780 feet of sheet piling to protect the river banks; dredging 38,224 cubic yards from between the piers 120 apart, and in widening the river; dredging 2,000 cubic yards on the outer bar; removing the existing south pier; all at an estimated cost of $128,288.4[illegible]. This project was adopted by the river and harbor act approved March 2, 1867. (Annual Report for 1866, p. 149 to 153.)

By June 30, 1876, 1,102 feet of crib work and 525 feet of pile work was constructed. The depths maintained were generally about 8 or 9 feet. (Annual Report for 1876, p. 512.) By June 30, 1877, the project was completed except that the minimum channel depths were still about 8½ feet. (Annual Report for 1879, p. 1628.) The depth of 12 feet was secured by 1880.

The project was modified by the river and harbor act approved June 14, 1880, to provide for an entrance channel not less than 14 feet depth, datum not stated. (Annual Report for 1880, p. 218.)

The project was modified by the river and harbor act approved August 2, 1882, which provided "$3,000 for removing obstructions in and dredging channel of river to railroad bridge." There being no railroad bridge, this modification was reenacted by the river and harbor act approved August 11, 1888, which provided that $3,000 "shall be used in deepening the channel of Black River from the inner termini of the piers to the highway bridge." The bridge is correctly referred to as "highway bridge" in the latter act.

3. SAUGATUCK HARBOR AND KALAMAZOO RIVER, MICH.

The original project provided for improving the entrance as it existed in July, 1867, by extending the south pier 416 feet, to the depth of 12 feet of water, and the north pier 1,632 feet, also to a depth of 12 feet, these piers to be parallel to each other, and 200 feet apart; by dredging between the piers to a depth of 12 feet (datum not stated); also by cutting a channel in the bay 200 feet wide and 12 feet deep, to connect with the deep water near the first bend; all at an estimated cost of $203,295.80. This project was adopted by the river and harbor act approved July 25, 1868. (Annual Report for 1867, p. 130 to 132, and for 1876, p. 509.)

No Government improvement had been undertaken up to July 23, 1869, when a board of engineers recommended a modification of the

Digitized by Google

projects, to protect the river banks inside of the existing piers, as follows: To revet the left or south bank at the bend, then continue that revetment to the east end of the south pier, a total length of 2,700 feet, at an estimated cost of $27,097.58; to build 1,660 feet of revetment on the north side of the river to the lake shore line, 770 feet of close piling from the shore line to the inner end of the proposed north pier cribwork, 192 feet of cribwork in extension of the north pier, and dredge 60,740 cubic yards, a total for the north side and for dredging of $59,300.98; total for the project, $86,398.56. The appropriations of July 25, 1868, and of April 10, 1869, were applied to the construction of a south revetment. The project was adopted by the river and harbor act approved July 11, 1870. (Annual Report for 1869, p. 99 to 101; 1874, p. 190; and 1876, p. 509 and 510.)

Construction under the project was carried on quite vigorously up to 1876 and again in 1880 and 1881. By that time the works on the north side consisted of a pile pier and revetment 715 feet long, and beginning about 1,750 feet upstream, a pile revetment at the bend 1,193 feet long; those on the south side consisted of a pile pier 286 feet long and a pile revetment 3,577 feet long. The width between the entrance piers was 228 feet. No further new work was built under this project.

Under date of June 28, 1882, a Board of Engineers on Saugatuck Harbor submitted a report as a result of which the river and harbor act approved August 2, 1882, adopted a project for the maintenance of this harbor at the existing depth, i. e., 8 feet. (Annual Report for 1883, p. 1829.) An uncertain channel with a depth of from 4 to 8 feet was maintained.

To June 30, 1906, there had been expended $207,785.92, of which $90,231.99 was for construction and $117,553.93 for maintenance.

4. HOLLAND HARBOR, MICH.

The river and harbor act approved August 30, 1852, appropriated $8,000, thereby adopting a project to make a cut through the shore from Black Lake to Lake Michigan, at an estimated cost of $105,225.78. The results of this expenditure are unknown.

About 1860 the harbor commissioners of Holland adopted a project for cutting a channel into Lake Michigan from Black Lake and by 1866 had expended $30,000, building a north pier 125 feet long, a south pier 77 feet long, and obtaining a channel 175 feet wide and 5½ feet deep. The river and harbor act approved June 23, 1866, appropriated $55,615.31, which was expended on the project adopted by the river and harbor act approved March 2, 1867. This provided for extending the existing north pier about 250 feet and the south pier about 275 feet to bring them into 12 feet of water; to close pile the entrance into Black Lake for 1,125 feet on the north side, and 425 feet on the south side to reach the 12-foot curve, to dredge 80,000 cubic yards from the channel; all at an estimated cost of $106,238.04. (Annual Report for 1866, p. 106 to 109.)

The following table shows the length and time of construction of the revetments and piers under this project with its various modifications. All cribwork is in extension toward Lake Michigan, of

Digitized by Google

the piers, except 47 feet on north pier and 64 feet on south pier, both constructed in 1868, which were built toward shore:

Year.	North shore.		Year.	South shore.	
	Crib-work.	Revet-ment.		Crib-work.	Revet-ment.
Before 1866	125		Before 1866	77	
1868	47		1868	64	
1868–69	258		1868–70	298	
1870		607	1870		150
1871	32		1871–73		621
1872		321	1874		15
1873		209	1874–89		86
1875–76	154		1875	100	
1880	101		1876	53	
			1878	51	
			1880	55	
			1889		121
Total	717	1,137	Total	698	993
Grand total, north side	1,854		Grand total, south side	1,691	

This work secured a channel from Black Lake to Lake Michigan from 8 to 9 feet below low water, deepened by occasional dredging to 12 and 13 feet.

6. GRAND RIVER, MICH.

The original project was adopted by the river and harbor act approved March 3, 1881, which appropriated $10,000 for "improving Grand River from its mouth to the city of Grand Rapids, Mich." The project provided "for dredging, where needed, a channel 100 feet wide and 4 feet deep, low stage from Grand Rapids to deep water." (Annual Report for 1881, p. 2224 to 2230.) Between 1881 and 1886 $50,000 was expended in dredging narrow channels across the bars to a depth of 4 feet.

The river and harbor act approved June 3, 1896, adopted a project for a channel 100 feet wide and 10 feet deep below standard low water of 1889 from Grand Rapids to Grand Haven, requiring the removal of 4,000,000 cubic yards; for enlargement of channel at Grand Rapids to form a turning basin, requiring the removal of 70,000 cubic yards; for wing dams and training dikes, if found necessary; all at an estimated cost of $670,500. (H. Doc. No. 197, 52d Cong., 1st sess.)

The project was amended by the river and harbor act approved June 13, 1902, which provided for extending the improvement as far north as Fulton Street, in Grand Rapids, an extension of about one-half mile, and the estimated cost was increased from $670,500 to $774,000. (Annual Report for 1903, p. 510.)

To June 30, 1887, there had been expended the sum of $50,000.

There was expended to October 1, 1903:

For dredging	$76,058.41
For training walls	74,512.66
For plant then available for prosecuting work	21,220.33
	171,791.40

Digitized by Google

7. MUSKEGON HARBOR, MICH.

The original project adopted by the river and harbor act approved March 2, 1867, provided for extending both of the existing piers, commencing at their outer ends, on a line parallel to the inner face of the south pier to 17 feet of water, requiring 700 feet of pier work, at an estimated cost of $58,450. (Annual Report for 1866, p. 146; and for 1867, p. 110.)

The project was amended by the river and harbor act approved June 10, 1872, to include reconstructing 350 feet of south slab pier and 250 feet of north slab pier into pile piers. (Annual Report for 1873, pp. 38 and 271.)

The project was amended by the river and harbor act approved June 23, 1874, to provide for an extension of the south pier 400 feet to 18 feet of water, at an estimated cost of $56,000. (Annual Report for 1873, p. 271; and for 1874, p. 183.)

The project was modified by the river and harbor act approved August 2, 1882, in accordance with a plan submitted by a board of engineers in April, 1881, which provided for increasing the width of entrance from about 186 feet to 300 feet by constructing a detached section in extension of the north pier 300 feet north of the south pier. (Annual Report for 1881, p. 2217; for 1884, p. 1984.)

A special report of December 23, 1889, recommended the removal of the outer 315 feet of the old north pier, constructing 326 feet of new work to connect the inner end of the detached north pier with the resulting outer end of the old north pier, all at an estimated cost of $34,000. (Annual Report for 1890, pp. 2644–2646.) This modification of the project was adopted by the river and harbor act approved September 19, 1890.

A special report of January 25, 1892, recommended 1,600 feet of pier extension, 800 feet to each pier, to the 20-foot contour (below mean lake level, 1860–1875) in Lake Michigan to create and protect a clear 15-foot navigation; dredging the channel from lake to lake 75 feet wide and 18 feet deep below mean lake level; 5,600 feet of revetment for unprotected banks; all at an estimated cost of $260,000. (Annual Report for 1892, pp. 325, 2338–2340; for 1894, p. 345.) This modification of the project was adopted by the river and harbor act approved August 18, 1894.

The project was amended by the river and harbor act approved March 3, 1899, which appropriated $60,000 and provided: "That any portion of the above sum may be used at the discretion of the Secretary of War, in sheet piling or otherwise, to prevent erosion and preserve the channel at any point where it may be necessary between Lake Michigan and Muskegon Lake."

Under the above project and its modifications there was constructed a north pier and revetment 2,780 feet long, and a south pier and revetment 2,090 feet long, protecting a channel with an entrance width of 308 feet narrowing to 167 feet inside, and with the project depth of 15 feet at low water. To June 30, 1902, there had been expended $526,293.36, of which $388,218.42 was for construction and $138,074.94 for maintenance. (Annual Report for 1902, p. 467.)

Digitized by Google

9. LUDINGTON HARBOR, MICH.

The project originally adopted by Congress (river and harbor act approved Mar. 2, 1867) for the improvement of this harbor was to build a south pier, commencing at a point 20 feet south of the existing slab pier, extending into Lake Michigan 640 feet; to build a north pier in extension of the existing (1867) pier 450 feet long; to remove the old slab pier on south side and cut down slab work on north side, replacing it by timber superstructure; to close pile the south side and to dredge to a depth of 12 feet if necessary. The direction of the piers was north 3° west, the channel width 200 feet, the depth 12 feet (datum not stated), and the estimated cost $270,682. (Annual Report for 1867, p. 114; for 1874, p. 178; and for 1876, p. 474.)

In 1875 it was stated that a channel with 14 feet depth of water was required to provide for the necessities of trade, and to obtain and maintain such a depth an extension of 150 feet to each pier was recommended at an estimated cost of $36,000. (Annual Report for 1875, p. 47; and for 1879, p. 1607.)

In 1879 the length of piers as above recommended had been reached, but the depth of water required by vessels seeking to use the port was 16 feet, and a further extension of the piers was recommended. The original estimated cost, as amended in 1879, was $213,787.07. (Annual Report for 1879, p. 1607.)

A report on a harbor of refuge was made under date of March 7, 1882, which recommended an exterior breakwater. (Annual Report for 1882, p. 2293.) A second report with plan and estimate for a harbor of refuge was submitted under date of October 27, 1883. This report submitted two plans, the first for an exterior harbor, with detached breakwater, at an estimated cost of $861,260, and the second for widening the entrance to 400 feet.

The second plan provided for widening the existing channel between Lake Michigan and Pere Marquette Lake to 400 feet by constructing a new south pier 400 feet south of the north pier, removing the existing south pier, and dredging the channel to a depth of 18 feet (datum not stated), all at an estimated cost of $419,185.20. The second plan was approved by the Chief of Engineers January 6, 1885, and was adopted by the river and harbor act approved August 5, 1886. (Annual Report for 1884, p. 1999, and for 1885, pp. 317, 2073, and 2090–2094.)

The Annual Report for 1888, page 1906, states:

> The work of carrying out the present project has been delayed by the fact that no authority existed for the acceptance by the United States of a strip of land needed for the widening of the channel. An enabling act was passed by Congress, approved April 24, 1888, authorizing the acceptance by the United States of the above-mentioned strip of land, which the Pere Marquette Lumber Co. has offered to donate. Negotiations are now in process for the transfer of this land to the United States, and as soon as it shall have been effected, work will be commenced on the present project with the funds available.

By deed of June 13, 1888, the land required for widening the harbor was donated to the United States. This deed conveyed a strip of land about 224 feet wide south of and adjoining the south revetment, and extending from lake to lake, a distance at that time of about 666 feet, and conveying riparian rights on each lake. The river and

Digitized by Google

harbor act approved August 11, 1888, authorized and directed the Secretary of War to accept the deed, tendered by the Pere Marquette Lumber Co., of 3.31 acres of land.

In a special report, dated December 31, 1889, it was recommended that the project be modified so as to retain the south pier and to prolong it 700 feet, at an estimated total cost of the project of $325,000 in place of $419,185.20. This was approved by the Chief of Engineers under date of January 9, 1890, and transmitted to Congress by the Secretary of War, with his approval, under date of January 11, 1890. (Annual Report, for 1890, pp. 2634–2631.) The construction of the piers to their full length, by the extension of the north pier 500 feet and the south pier 700 feet, was completed in November, 1890, the north pier having a length of 1,450 feet and the south pier 2,300 feet; the entrance width was 250 feet, narrowing to 200 feet at the shore line. (Annual Report for 1891, pp. 338 and 2682.)

A special report of January 2, 1897, submitted a new project for improving the harbor so as to maintain a channel 18 feet deep at the existing water level of Lake Michigan, which was 2 feet below mean lake level, 1860 to 1875. This project provided for 700 feet extension to the north pier and 300 feet to the south pier; for dredging 60,000 cubic yards; for reconstructing 1,600 feet of piers; for repairs to 567 feet of pile revetment, south pier; for minor repairs to the remaining piers; all at an estimated cost of $210,000. This project was adopted by the river and harbor act approved March 3, 1899 (in accordance with the report and plan submitted in H. Doc. No. 273, 54th Cong., 2d sess; see also Annual Report for 1897, pp. 2951–2953).

In its final form as adopted March 3, 1899, the project provided for a through channel 183 to 285 feet wide and 18 feet deep below low water, protected by the requisite piers and revetments. The development of the harbor was progressive, the changes in the original project affecting only the length and direction of the piers and the depth between them.

The total amount expended upon the original and modified projects was $617,867.72, of which $491,416.22 was for construction and $126,451.50 for maintenance.

10. MANISTEE HARBOR, MICH.

Before improvement was begun by the United States the entrance from Lake Michigan had been improved by local interests by slab piers from 100 to 150 feet apart, and the depth was from 7 to 8 feet in an uncertain channel obstructed by sand bars.

The first reference to a project is given in the Annual Report of the Chief of Engineers, 1866, page 142, the project there stated providing for 1,000 feet of cribwork for each pier, a total of 2,000 feet, at an estimated cost of $167,000, and for dredging between the proposed piers and for a distance of 350 feet in the river to a depth of 12 feet at a cost of $13,949, making a total estimated cost of $180,949. This project was adopted by the river and harbor act of March 2, 1867. The project as given in Annual Report, 1867, page 115, was to extend the existing south pier in the same direction 960 feet; to extend the existing north pier 960 feet parallel to the south pier to 12 feet of water; to cut off a point of slab work inside the south pier and widen the channel; to cut down all slab work to water surface and build

Digitized by Google

cribwork superstructure on the old foundation; and to dredge the channel to a depth of 12 feet. No datum plane was given. Fourteen 32-foot cribs had been placed prior to September 1, 1867. A slight change of plan was caused by the washing away of the outer 100 feet of the existing north pier.

The Annual Report for 1871, page 136, states that the north side of the channel would have to be protected by a pile revetment from the east end of the north pier 850 feet inward at a cost of $13,812.50. The construction of 600 feet of this revetment was begun in August, 1872, and completed in May, 1873, with funds from the appropriation of June 10, 1872. (Annual Report for 1873, p. 263.)

The Annual Report for 1872, page 186, states that to carry out the adopted harbor design would require the construction of 580 feet of revetment on the south side after dredging away the point as provided for in the 1867 project. Work on this south revetment was begun in July, 1873, with funds from the appropriation of June 10, 1872. (Annual Report for 1873, p. 263.)

The Annual Report for 1873, page 263, gives an estimate for pier extension to a depth of 16 feet (datum plane not stated), increasing the proposed lengths of piers from 960 feet for each pier to 1,288 feet for the north pier and 1,387 feet for the south pier. This proposed extension, 650 feet to the north pier and 750 feet to the south pier, was estimated to cost $112,000. The original project of 1867 did not provide for any improvement in the river eastward of the shore ends of piers, but in 1873 the scope of operating was extended to include straightening the lower portion of the river by dredging and for revetting the banks inside of the pier ends. (Annual Report for 1894, p. 2223.)

In the Annual Report for 1875, page 246, it was recommended to remove the bend at the inner end of the north revetment, extend the north revetment 320 feet eastward, and deepen the channel between the piers to 12 feet (datum not stated), at a cost of $13,771.40. This work was provided for by the appropriation of August 14, 1876, and funds remaining from the appropriation of March 3, 1875. (Annual Report for 1876, p. 100.)

The estimate of 1873, $112,000 for pier extension, and the estimate of 1875, $13,771 for revetment and for dredging, made a total of $125,771, to complete all improvements. (Annual Report for 1876, p. 469.)

The project was again enlarged (Annual Report for 1891, p. 2678), as follows:

> The special report made under date of December 14, 1889 (Annual Report for 1890, pp. 2618, 2619), having been approved by the Chief of Engineers, constituted in effect a new project for Manistee Harbor and was the basis of the appropriation of September 19, 1890. The former project was for a 12-foot navigation into Manistee River. The later project increases the depth to 15 feet and extends the channel through to Manistee Lake, a total distance of about 8,000 feet, making provision for dredging throughout this length and for considerable extension of the entrance piers into the lake, viz, 11 new cribs, 550 feet, on the north pier, and 7 new cribs, 350 feet, on the south pier, to enable them to reach the 18-foot contour.

The 15-foot channel was dredged for a width of 50 feet in the upper portion, increased to 75 feet and 100 feet as the entrance was approached.

Digitized by Google

The river and harbor act of July 13, 1892, which appropriated $50,000 for continuing improvement and for repairs of Manistee Harbor, modified the project as follows:

Provided, That no part of this sum shall be used in aid of the inner navigation until the city authorities or private owners have taken proper steps to prevent erosion of the banks and the washing of silt into the bed of the river. (Annual Report for 1893, p. 2898.)

The river and harbor act approved March 2, 1907, changed the project. (H. Doc. No. 511, 59th Cong., 1st sess.) It provided for securing a uniform depth of 18 feet at low water from Lake Michigan to Manistee Lake with a general width of channel of 120 feet, widened to 275 feet at the inner end of the north revetment; for extending the south pier 300 feet, so that both piers would end at the 20-foot contour in Lake Michigan; for 1,225 feet of new revetment, 825 feet on the south side and 400 feet on the north side; and for 2,250 linear feet of pile protection work along the river. The estimated cost was $147,488, with $1,500 annually for maintenance after completion. The approval of the project was subject to the proviso that no work should be undertaken by the United States until local authorities reconstructed the bridges as recommended, deeded to the United States the land necessary for the proposed widening of the river channel, and protected the United States against all claims for damages which might result from caving of river banks due to the proposed improvement. This project was not carried out as the local authorities failed to comply with the conditions.

The river and harbor act approved June 25, 1910, modified the project by providing for a channel 18 feet deep at the entrance and 16 feet deep and 90 to 126 feet wide through the river to Manistee Lake at an estimated first cost of $25,000, and such amounts for annual maintenance as found necessary. The depth were referred to low water. (H. Doc. No. 705, 61st Cong., 2d sess.)

12. ARCADIA HARBOR, MICH.

The original project was adopted by the river and harbor act approved March 3, 1905, for maintenance of a channel not less than 50 feet wide and 12 feet deep below low water (2 feet below mean lake level, 1860–1875) at an annual expense of $3,000 for a period of five years. (H. Doc. No. 194, 58th Cong., 2d sess., and Annual Report for 1904, pp. 3037–3048.) The harbor had been built by private interests and consisted of a channel between parallel piers extending from Bar Lake to Lake Michigan. The five years covered by this project were the calendar years 1905 to 1909, inclusive.

15. PETOSKEY HARBOR, MICH.

The earliest action of Congress looking to harbor improvement at Petoskey was the provision in the river and harbor act of July 5, 1884, for a survey and examination of Little Traverse Bay, near the village of Petoskey, with the view to constructing a harbor of refuge. The report in compliance therewith was unfavorable (H. Doc. No. 71, 48th Cong., 2d sess.; Annual Report for 1885, p. 2095), but the river and harbor act of August 11, 1888, again took up the matter by requiring an examination and survey of "Petoskey Harbor, for

Digitized by Google

breakwater and harbor of refuge." This resulted in a report, dated December 21, 1889 (Annual Report for 1890, p. 2673), which presents two projects. The smaller, at an estimated cost of $70,000, contemplated the rebuilding of the landing pier in front of the village and extending it into an L or arm to the eastward, so that vessels could safely lie in the angle. The larger project, at an estimated cost of $170,000, contemplated crib breakwater construction 1,750 feet long to protect the landing pier from north and west storms.

Congress appropriated $15,000 in river and harbor act approved September 19, 1890, which was construed to adopt the larger of the two projects, but the river and harbor act of July 13, 1892, appropriated additional funds and provided that these funds, as well as those previously appropriated, should be used to improve the harbor in compliance with the smaller of the two projects.

No construction work in the field was begun before the present project was adopted (river and harbor act of Aug. 18, 1894).

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE DETROIT, MICH., DISTRICT.

---

2. ST. MARYS RIVER AT THE FALLS, MICH.

The original improvement by the United States of the section of the St. Marys River at the falls was begun under a project authorized by the act of July 11, 1870, which provided for increasing the width of the then State Canal to at least 100 feet, replacing the stone slope walls with timber revetment piers, building a new lock, and providing for 16 feet draft. The project called for a single-chamber lock 515 feet long between service gates and 80 feet wide (narrowed at gate openings to 60 feet), arranged for 18 feet average lift and with a depth over the miter sills of 17 feet at mean stage of water then prevailing. This lock (now known as the Weitzel Lock) was opened to traffic in 1881.

The river and harbor act of August 5, 1886, authorized the execution of a project for building, on the site of the old State locks, a new lock with a single lift of 16 to 21 feet, the chamber being 800 feet long by 100 feet wide, with a project depth of 22 feet on the miter sills at mean stage of water then prevailing; also for deepening the canal and its approaches, all at an estimated cost of $4,738,865. The new lock constructed under this project, and known as the Poe Lock, was opened to navigation August 3, 1896. Later work consisted in completing the deepening of the canal and its approaches, rebuilding and extending canal piers, grading and improving canal grounds, etc.

The river and harbor act of June 13, 1902, provided for extending the work at the falls so as to include widening and further improvement of the canal above the locks, in accordance with the project submitted in House Document No. 128, Fifty-sixth Congress, second session, but made no additional appropriation therefor.

The river and harbor act of March 3, 1905, authorized the expenditure under continuing contract of $1,020,000, all of which has been

Digitized by Google

appropriated, for widening canal as proposed in project submitted in House Document No. 215, Fifty-eighth Congress, third session.

The project of 1886 and its extensions and modifications, for general improvement, has been completed, giving a canal 1⅜ miles long, with widths of 108 to 500 feet and depth of 24.6 feet in the upper portion, a movable dam for closing the canal in an emergency, and a lock 100 feet wide and 800 feet long between service gates.

The draft which can be carrried through the Weitzel and Poe Locks at present is about 12.6 and 18 feet, respectively, at extreme low-water stages of the lower pools, 580.6 feet above mean tide at New York. The water level below the locks varies about 1 foot during the year.

4. HAY LAKE AND NEEBISH CHANNELS, ST. MARYS RIVER, MICH.

In 1856 the United States entered upon the general improvement of the St. Marys River, under authority of act of July 8, 1856, the funds appropriated being devoted principally to the channel 14 feet deep through Lake George; some work was also done along the western bank of the East Neebish Channel and some bowlders were removed from the entrances to the canal. This work resulted, by 1869, in giving a channel from Lake Superior to Lake Huron with a depth (about 11½ feet) as great as could be carried through the State canal and locks.

The act of August 2, 1882, authorized the project for a channel 300 feet wide, with a least depth of 17 feet, through all obstructed portions of the river from the foot of the locks to Lake Huron, by way of Hay Lake and the Middle Neebish. This project was modified by the act approved August 5, 1886, to provide a depth of 20 feet and to widen the channel at angles and critical places, at a total estimated cost of $2,659,115. The work covered by above project as modified was completed prior to beginning work on the present project.

6. CHEBOYGAN HARBOR, MICH.

The original project for work of improvement at this harbor, adopted by act of March 3, 1871, called for a channel 200 feet wide and 14 feet deep from the 14-foot contour in the Straits of Mackinac to the mouth of the river, its sides to be protected by pile revetment and piers. Estimated cost, $395,335.

Operations under this original project were confined solely to dredging, which was carried to a depth of only 13 feet, no revetment or pier work being done.

In 1880, with the funds provided by act of June 14, 1880, operations were begun in accordance with a project which had for its object the securing of a 15-foot depth in the channel. The work was prosecuted with the funds provided by subsequent appropriations, and a channel of this depth, having a width of 200 feet, was provided from the 15-foot contour in the straits to the State road bridge, as well as a turning basis, with clear 15-foot depth in front of the steamboat docks.

Digitized by Google

8. ALPENA HARBOR (THUNDER BAY RIVER), MICH.

The original project for the improvement of this harbor, authorized by act of August 14, 1876, contemplated a channel 200 feet wide and 13 feet deep from the first bridge to the 13-foot contour in Thunder Bay.

This project was modified in 1882 to increase this depth to 14 feet, and a 14-foot depth was secured the following year with the funds provided by act of August 2, 1882.

9. SAGINAW RIVER, MICH.

The original project for the improvement of this river was authorized by the act of June 23, 1866. It provided for a channel across the bar in Saginaw Bay, at the mouth of the river, 12 feet deep and 195 feet wide across the bottom. This channel was completed in 1869.

In 1874 (act of June 23, 1874) the project was extended to include the improvement of the river above Bay City so as to secure a 10-foot channel across the bars at East Saginaw and Carrollton and the construction of a pile revetment at the latter place. This work was completed in 1878.

In 1878 (act of June 18, 1878) the project was extended to cover the construction of a wing dam at Zilwaukee bar, and the dam was built that year.

In 1879 (act of Mar. 3, 1879) the project was still further extended to secure a 10-foot channel at New York Works bar and Willow Island bar and the construction of a plank beam revetment at the latter place.

In 1882 (act of Aug. 2, 1882) a project was adopted, covering the entire river, which provided for a channel 200 feet wide and 14 feet deep from Saginaw Bay to Portsmouth Street Bridge in Bay City, and thence a channel of same width, 12 feet deep, to the head of the river, and the construction of cross dams at Carrollton and Oneida Channels, the plane of reference for dredging being 581.1 feet above mean tide New York. The estimated cost was $446,000. By the river and harbor act of August 5, 1886, the improvement of the west channel along West Bay City was added to this project. Work was prosecuted under this project up to the time of the adoption of the existing project, and a channel of the required depth, but of varying widths, was obtained and maintained.

11. MOUTH OF BLACK RIVER, MICH.

The original project for this improvement, authorized by act of June 10, 1872, contemplated the removal of the bar at the mouth of the river and the middle ground in the St. Clair River to a depth of 15 feet over an area of 46.6 acres. Estimated cost, $67,320. The work was begun in 1872 and completed in 1878.

13. ST. CLAIR FLATS CANAL, MICH.

The original project for the construction of this canal, authorized by the act of March 2, 1867, provided for the construction of a straight ship canal at the mouth of the South Pass of the St. Clair

Digitized by Google

River through the shoal to deep water in Lake St. Clair, a distance of about 1½ miles, the canal to be 300 feet wide and 13 feet deep at low stage of water and to be protected by dikes 5 feet high and 58 feet wide on top, built of the dredged material thrown behind a pile and timber revetment. This work was completed at a cost of $461,090.01 and the canal was opened to the public on July 25, 1871.

In 1873 (act of Mar. 3, 1873) the project was modified so as to secure a depth of 16 feet in the canal. The work of deepening was begun that year and completed in September, 1874.

In November, 1886, a general plan was submitted for improving the canal, which contemplated driving a double row of sheet piling to a depth of 26 feet along the channel face of each dike, dredging the channel to a depth of 20 feet, continuing this channel above and below the canal to the same depth in the river and lake, and rebuilding the wooden superstructure. This plan was approved and the funds provided by the acts of August 5, 1886, and August 11, 1888, were devoted to the work on the dikes, no work of dredging being done until after the approval of the act of September 19, 1890, when a contract for deepening the channel to 18 feet was entered into. This contract was completed in July, 1892.

14. CLINTON RIVER, MICH.

The original project for the improvement of this river was authorized by act of August 30, 1852, and provided for the improvement of the mouth of the river. Its scope is not known.

In 1870 (act of July 11, 1870) a project was adopted for dredging a channel 100 feet wide, 8 feet deep, and 2,700 feet long nearly straight out from the mouth of the river. This channel was secured that same year.

In 1880 a board of engineer officers submitted a plan, which was later approved, for a cut 8 feet deep and 60 feet wide at the entrance to the river, the dredged material to be used to form banks, these banks to be protected by planting them with willow or wild rice. Work was prosecuted under this plan, but the results were not entirely satisfactory and the existing project was adopted.

16. DETROIT RIVER, MICH.

The original project for the improvement of the Detroit River was authorized by act of June 23, 1874. It provided for a channel at the Limekiln Crossing at least 20 feet in depth, about 3,000 feet in length, and 300 feet in width, conforming with the natural course of the river. Estimated cost, $1,166,500. Work was begun in 1876 and continued until 1883. In 1884 (act of July 5, 1884) this project was modified so as to secure a straight channel of the same width and depth, and the estimated cost was increased by $40,000. The 300-foot channel proving too narrow for safe navigation, the project was further modified and the width increased to 400 feet in 1886 (act of Aug. 5, 1886). The estimated cost of this addition was $168,000. In expending the funds provided by the act of July 31, 1888, the channel was further widened 40 feet. The work was com-

Digitized by Google

pleted in 1890, and the project channel at the Limekiln Crossing secured at a total cost of $702,122.04.

In 1892 the project was modified and extended to provide for the removal of obstructive shoals between the city of Detroit and Lake Erie, with a view to obtaining a channel with a least width of 600 feet and a navigable depth of 20 feet, adopted by acts of July 13, 1892, and March 3, 1899. The estimated cost of this additional work was 180,000, making the total estimated cost of the channel $1,554,500, and this amount was appropriated and expended prior to beginning operations under the present project.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE CLEVELAND, OHIO, DISTRICT.

---

1. TOLEDO HARBOR, OHIO.

The first appropriation for improvement, made by the river and harbor act of June 23, 1866, was applied to increasing the depth and width of the natural channel through Maumee Bay, which was about 7½ miles long. An effort was made to obtain a channel 12 feet deep.

In 1872 the Secretary of War approved a project "to improve the existing natural channel through Maumee Bay by widening it to 250 feet at the surface and 200 feet at the bottom, with a depth of 15 feet." (Annual Report of the Chief of Engineers, 1873, p. 313.) In 1880 a channel 200 to 250 feet wide was available to the docks at Toledo. By the river and harbor act of June 14, 1880, the project depth was made 16 feet.

By the act of July 5, 1884, a project was adopted "for extending Maumee River on a straight line through the bay and North Cape Point to Lake Erie, confining the river bed in a new channel of about the same dimensions as its natural bed." This provision was modified by the river and harbor act of August 5, 1886, which provided for continuing improvement of Maumee River "by a straight channel along such line as may be approved by the Secretary of War." Under this authority the Secretary of War adopted, April 27, 1887, the project recommended by the Board of Engineers that the straight channel "be obtained by extending the Crib Reach, so called, of the present natural channel outward into Lake Erie and inward across the bay to the present natural channel of the Maumee River." (Annual Report of the Chief of Engineers, 1887, p. 2297.) The project was for a channel 200 feet wide and 17 feet deep, with a total length of 7½ miles from the mouth of the Maumee River to curve of 17 feet depth in the lake.

The river and harbor acts of July 13, 1892, August 18, 1894, and June 3, 1896, authorized extending the improvements up the Maumee River. Under these authorities channels 400 feet wide and 18 feet deep over two shoals, known as "The Crossing" and the "Lake Shore Shoal," each about 4,000 feet long, were dredged. In 1897 the "Straight Channel" had been completed to full width of 200 feet and a depth of 17 feet at average low water.

Digitized by Google

8. SANDUSKY HARBOR, OHIO.

The first appropriation was made for a survey by the river and harbor act of May 20, 1826, and the first appropriation for improvement was made by river and harbor act of June 11, 1844, providing funds "to be expended by the Secretary of War and according to such plan of improvement as may be recommended by him." Available funds were expended for constructing a dam of cribwork about 1,350 feet long, partially closing a breach across Sand Point, which was a long, sandy peninsula extending from the north shore of Sandusky Bay toward Cedar Point. The object of the work was to confine the scour to the main channel.

In 1853–54 additional cribwork about 3,350 feet long was built on Sand Point, but in 1859 this was almost entirely destroyed, and in 1864 the greater part of Sand Point had been washed away. The appropriations made by river and harbor acts of June 23, 1866, to July 11, 1872, inclusive, were expended for dredging a channel 400 feet wide and 12 feet deep through the outer bar, and a channel 90 feet wide and 12 feet deep through the inner bar. The appropriation made by river and harbor act of March 3, 1873, was expended for dredging a channel through the outer and inner bars 14 feet in depth to the area included by the curve of 12 feet depth in the bay. (For report on survey, see Annual Report, Chief of Engineers, 1873, p. 328.)

In 1877 an extension of the project was approved to provide for completing a channel 200 feet wide and 15 feet deep at low water up to the city docks.

In 1878 a cut 150 feet wide and 14 feet deep at average low water had been dredged from the curve of 12 feet depth in the bay to the curve of 15 feet depth in the lake along the natural or "west channel," a distance of about 4½ miles.

In 1880 dredging a channel 100 feet wide, 15 feet deep, and parallel with the docks at a distance of 50 feet was authorized. In 1881 the channel had been dredged 100 to 200 feet wide and 15 feet deep through the outer bar and up to within 100 feet of the docks. This work was completed in 1883.

The river and harbor act of July 5, 1884, provided for "deepening the channel." It had been recommended that the channel depth be made 16 feet.

The river and harbor act of August 11, 1888, provided for maintenance of the old channel and for dredging "a straight channel from Sandusky City to the entrance of Sandusky Bay." The estimated cost of a channel 200 feet wide and 17 feet deep at low water from the north end of Cedar Point to the east end of the then existing channel in front of the city, a distance of about 1¾ miles, was $96,712. (Annual Report, Chief of Engineers, 1888, p. 1991.)

The "straight channel" was completed in 1894 at a cost of $112,984, and in 1895 a depth of 18 feet was provided over the outer bar and a depth of 17 feet was provided in the dock channel. The appropriation made by the river and harbor act of August 18, 1894, was applied to a project for dredging a channel 300 feet wide and 18 feet deep over the outer bar; for the construction of a jetty 2,500 feet long, starting at Cedar Point and extending to the eastward of this outer

Digitized by Google

channel; for the construction of a dike 2,500 feet long to the westward of the outer channel; for dredging the straight channel slopes and widening at both ends; and for dredging the dock channel for a length of 6,500 feet to a width of 200 feet and a depth of 17 feet, all at an estimated cost of $255,000. (H. Doc. No. 91, 53d Cong., 3d sess., and Annual Report, Chief of Engineers, 1894, p. 3085.)

4. HURON HARBOR, OHIO.

The first appropriation for the improvement of this harbor was made by the river and harbor act of May 20, 1826, "to remove obstructions in Huron River." At that time the mouth of the river was closed by a sand bar which was bare at low water. In order to maintain a channel the river mouth was confined between piers, which, in 1833, were 170 feet apart at the inner end and 140 feet at the outer end and extended into the lake about 1,000 feet. The depth in the channel between the piers was 10 feet.

No appropriations were made during the years 1853–1865, inclusive, and at the end of that period extensive dredging and repairs to piers were required.

In 1871 a depth of 15 feet was obtained by dredging.

The river and harbor act of September 19, 1890, provided for amending the project "to give 16-foot depth at low water." This result was accomplished by dredging and by extending the piers to the curve of 16-foot depth in the lake. Under this same act (Sept. 19, 1890) the work of the United States was supplemented by dredging by the Wheeling & Lake Erie Railroad Co. From 1890 to 1903 a depth of 19 feet was available from the inner end of the piers to deep water in the lake.

6. LORAIN HARBOR, OHIO.

By the river and harbor act approved May 23, 1828, Congress made an appropriation for the construction of piers or other works at the mouth of Black River for the purpose of causing sufficient scour to maintain a navigable channel across the bar, on which the depth at that time did not exceed 3 feet at ordinary lake level. The piers were originally 170 to 210 feet apart.

In 1839 the piers were about 1,200 feet long, but owing to the advance of the shore line on each side of the channel they extended into the lake only about 800 feet beyond the new shore line. The prevailing depth in the channel was 9½ feet, but increased to 14 feet near the outer end of the piers.

During the years 1853–1864, inclusive, no funds were available for improvement. The piers, especially the east pier, were very badly damaged, and only a narrow channel, with a depth of from 7 to 10 feet, remained near the west pier.

The piers were repaired in 1865 and 1866, and the channel at once began to improve. The piers were gradually extended into the lake to prevent drift of sand around their outer ends and into the entrance channel.

In 1875 the piers extended to the curve of 15-foot depth in the lake, and a channel depth of 14 feet at low stage of the lake was secured.

Digitized by Google

In 1879 the channel was 15 feet deep across the outer bar, 15 to 17 feet deep betweeen the piers, and 17 to 20 feet deep from the inner end of the piers to the Erie Avenue Bridge.

In 1880 the project was modified to extend the piers to the curve of 16-foot depth in the lake, the object being to obtain a channel 16 feet deep at mean lake level.

In 1881 a sheet-pile revetment 400 feet long was built upstream from the inner end of the east jetty to prevent cutting of bank by the river when at flood stage.

In 1884 a channel with a least depth of 16½ feet was provided. Under act approved July 13, 1892, authority was given for extending the piers to the curve of 17-foot depth in the lake and obtaining a depth of 17 feet at mean lake level in the harbor. This depth was secured in 1896 and was increased to 18½ feet in 1898.

7. CLEVELAND HARBOR, OHIO.

The project adopted March 3, 1825, provided for parallel piers at the mouth of the Cuyahoga River, contracting the channel to a width of 200 feet, and extending out to the curve of 12 feet depth in the lake, the object being to obtain a channel 12 feet deep by scour. The piers were located so as to make a more direct outlet for the river, and the old outlet was closed by a dam. This project was completed in 1852. At that time the east pier was 1,400 feet long, the west pier 1,800 feet long, and there was a channel 200 feet wide and 13 feet deep.

The act of June 23, 1866, authorized the extension of the west pier 500 feet and the east pier 575 feet, and dredging the channel to a depth of 14 feet. This work was completed in 1875.

The project adopted March 3, 1875, provided for the construction of a breakwater in 5 fathoms of water to protect the commerce of Cleveland, in accordance with which the Secretary of War, on June 26, 1875, approved a plan for an outer harbor which, as later modified provided for a pile pier starting from a point on the shore about 700 feet west of the extremity of the old bed of the Cuyahoga River, 5,400 feet west of the west pier, extending into the lake on a line running about north 10° west (actually constructed on the magnetic meridian) to the 14-foot curve, a distance of 1,000 feet; thence continuing a farther distance of 2,130 feet to the 30-foot contour as a stone-filled timber crib breakwater on a rubblestone foundation; thence generally parallel with the shore and following the 30-foot contour a distance of 4,000 feet as a stone-filled crib breakwater on a rubblestone foundation to a point nearly in prolongation of the west channel pier of Cuyahoga River, which was to be extended to such a point as to leave a 300-foot opening into the outer harbor. (Annual Report Chief of Engineers, 1875, p. 304.) The estimated cost was $1,800,000. (Annual Report Chief of Engineers, 1876, p. 558.) This was modified in 1882 by providing for extending the east pier, instead of the west, and constructing a spur pier 100 feet long on the lake side of the breakwater 200 feet from its easterly extremity. (Annual Report Chief of Engineers, 1882, p. 2399.) Work under this project, except extension of east pier, was completed in 1883, at a cost of $800,000.

Digitized by Google

The act of August 5, 1886, adopted the following project for an east breakwater to form additional outer harbor east of the main entrance:

Beginning at a point on the prolongation of the lake arm of the west breakwater and 500 feet from it and extending eastward on this line 1,100 feet; then inclining to the shore and extending 2,400 feet in a depth of 25 feet of water, and having between its eastern end and the curve of 14 feet depth an entrance 1,200 feet wide. (Annual Report, Chief of Engineers, 1885, p. 2228.) This project was modified by the act of August 11, 1888, by extending the lake arm of the east breakwater to a total length of 3,500 feet; then inclining toward the shore on a line parallel with the then projected breakwater for a distance of 2,000 feet. In 1893, 2,500 feet of the east breakwater had been completed. In 1895, an opening 200 feet wide and 13 feet deep was made in the shore arm of the west breakwater by authority of the Secretary of War.

8. FAIRPORT HARBOR, OHIO.

The river and harbor acts of March 3, 1825, and May 20, 1826, provided, respectively, for "completing the pier at the mouth of Grand River" and "removing obstructions at the mouth of Grand River." Under the general provisions of these laws the improvement of the harbor, as undertaken, consisted in the construction of parallel jetties at the mouth of the river located 200 feet apart and extending into the lake to a depth of 16 feet below mean lake level. With the advance of the shore line the jetties were extended from time to time until the west jetty attained a length of 2,370 feet, and the east jetty 1,765 feet, from the original shore line. The depths obtained in the channel were 7½ feet in 1829, 11 feet in 1839, and 12 feet in 1853. In 1865 the channel had shoaled to 5 feet. In 1870 the depth was 12 feet, and in 1879, 14 feet.

In 1890 the project was modified to provide for extension of jetties to a depth of 18 feet in the lake and for maintaining the same depth in the jettied channel. (Annual Report for 1890, p. 2782.) These jetties have been repeatedly repaired and rebuilt as necessities required, and the channel has been deepened and dredged many times.

9. ASHTABULA HARBOR, OHIO.

The original project for the improvement of Ashtabula Harbor was inaugurated by the river and harbor act of May 20, 1826, which provided for the removal of obstructions at the mouth of Ashtabula Creek. Under this authority the plan of improvement determined upon consisted in the construction of two piers at the mouth of the river extending outward to a depth of 10 feet below mean lake level in the lake. The piers were located 160 feet apart at their inner ends, converging until they were 100 feet apart, 900 feet from shore, then widening to 160 feet in the next 200 feet, and parallel from this point outward. With funds appropriated from time to time after the inauguration of the project the piers were extended and repaired, and dredging, including the removal of rock, was carried on until in 1874 a channel depth of 14 feet below mean lake level had been obtained.

Digitized by Google

The river and harbor act of March 3, 1881, provided for securing a channel 16 feet deep below mean lake level. Under this authority 1,100 linear feet of the inner end of the west pier was rebuilt and relocated to provide a channel uniformly 160 feet wide, and the depth was increased to 16 feet.

A project approved July 8, 1890, by the Secretary of War, provided for increasing the depth of the channel between the piers to 20 feet below mean lake level and for extending the piers to 22 feet depth in the lake. (Annual Report of the Chief of Engineers, 1890, p. 2785.)

January 31, 1891, the Secretary of War approved an extension of this project to provide for moving the east pier 45 feet east, making the distance between piers 213 feet. (Annual Report of the Chief of Engineers, 1891, p. 2864.)

In 1890–91 a portion of the inner end of east pier was removed by the Lake Shore & Michigan Southern Railroad under permit from the Secretary of War to provide entrance to their slip.

The Secretary of War on October 14, 1895, approved an extension of the project for deepening the channel to 20 feet below mean lake level to include that portion of the river below the highway bridge. (Annual Report of the Chief of Engineers, 1896, p. 2961.) In 1897 the project depth of 20 feet below mean lake level had been obtained in the channel between the piers and as far as the county bridge, and the distance between piers was 213 feet.

10. CONNEAUT HARBOR, OHIO.

The original project, for which the first appropriation was made by the river and harbor act of March 2, 1829, provided for a new and more direct outlet for Conneaut River about 100 feet wide, protected by piers. The original mouth was closed by a dam, thus causing increased depth in the new outlet by scour. Some dredging was done to provide an inner turning basin. The project was regarded as completed in 1871. At that time the east pier was 1,071 feet long, the west pier 791 feet long, and the channel between them not less than 9 feet deep. A maximum depth of 11 feet was occasionally obtained under this project.

Between 1871 and 1880 the harbor was kept in repair so far as appropriations would permit. No appropriations were made for this harbor from 1880 to 1892. At the end of this period the piers were in a decayed and dilapidated condition, the channel had filled with sand and silt, and had practically reverted to its original condition. The harbor could only be used by small sailing and fishing craft.

The original project was modified by the river and harbor act of July 13, 1892, which provided for relocating the channel eastward of original project, constructing two new piers and revetments 200 feet apart extending to the curve of 17 feet depth in the lake, and dredging the channel 17 feet deep with a bottom width of 160 feet. (Scheme B of district engineer's report of Nov. 10, 1891; Annual Report of the Chief of Engineers, 1892, p. 2519.) It was found that the adopted project would involve a large amount of rock excavation, and the river and harbor act of February 24, 1893, modified the project previously approved to provide for widening and deepening the existing channel. (Scheme A of district engineer's report of

Digitized by Google

Nov. 10, 1891; Annual Report of the Chief of Engineers, 1892, p. 2518.) The dimensions were the same as those for scheme B.

A project was adopted by act of March 24, 1896, which provided for parallel piers 200 feet apart extending to the curve of 17 feet depth in the lake and the construction of two detached breakwaters, the outer ends terminating in pierheads 1,200 feet lakeward from the pier ends in a depth of about 25 feet of water, located at equal distances each side of the axis of the jettied channel and 350 feet apart. The breakwaters converged at an angle of 60°, 30° on each side of the channel axis. The west breakwater was to be 1,250 feet long and east breakwater 1,050 feet long. The project also provided for securing a depth of 20 feet below mean lake level in the channel and sheltered area. (Annual Report, Chief of Engineers, 1896, p. 2970, and H. Doc. No. 325, 54th Cong., 1st sess.)

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE BUFFALO, N. Y., DISTRICT.

---

1. HARBOR AT ERIE, PA.

The original improvement was made under provisions of the river and harbor act of May 26, 1824. The project provided for closing the eastern end of the harbor by a breakwater in which there should be an opening 200 feet wide, and for extending to deep water in the lake two parallel piers, one on each side of the opening. Provision was also made for protection of the beach by brushwood. The estimated cost of the project was $39,619.47 and it was completed in 1829, the depth in the channel at that time being 7½ to 15 feet. About $44,000 was expended in construction and repair work to that date.

Between 1829 and 1855, under appropriation aggregating $170,367.80, the north breakwater was prolonged 1,234 feet, existing structures were repaired and rebuilt, and about 4,400 linear feet of crib work was built to close a breach which occurred at the neck of the peninsula in 1833. A small amount of dredging was also done in the channel.

In 1855 the project was modified, in accordance with the recommendation of a board of engineers, to extend the north pier to the 12-foot curve in the lake, to widen the eastern entrance to the harbor to 500 feet by removing the old and building a new south pier, to construct channel piers to form a western entrance at or near the breach in Peninsula Point, and to check the abrasion and restore the original water line of the peninsula as far as possible. The estimated cost of the project was $269,105.37, but it was not carried out.

A modification adopted in 1865 provided for the extension of the north pier 500 feet into the lake to the 13-foot curve at an estimated cost of $15,126.90. This work was completed in 1867, when a further modification was adopted by the river and harbor act of March 2, 1867, which provided for a channel of 14 feet depth, the estimated cost being $54,666.

Digitized by Google

In 1870, upon the recommendation of a board of engineers, provision was made for the preservation of the peninsula protecting the harbor by planting trees and by a construction of brushwood and stone at an estimated cost of $10,000. This was done in 1871–72, over 50,000 trees and roots being planted.

In August, 1874, a board of engineers was convened to devise a mode of protection for the north spit at the entrance to the harbor. The recommendation of the board, which was approved, provided for a construction of pile work and rubble stone, which was built in 1874–75 to a length of 1,472 feet.

A modification providing for the extension of the piers to the 16-foot curve in the lake was adopted by the river and harbor act of August 5, 1886, the estimated cost being $84,120; and by the river and harbor act of September 19, 1890, a further modification providing for extension of the north pier to the 18-foot curve at an estimated cost of $96,000 was adopted. (Annual Report for 1890, p. 2796.) The north pier was extended under the project, between 1891 and 1893, a total distance of 753 feet.

The total amount expended on this harbor to 1899 was about $842,000.

2. HARBOR AT DUNKIRK, N. Y.

The harbor lies in an indentation of the shore between two points about 9,600 feet apart, the maximum width of the bay behind the two headlands being about 3,600 feet. The original project, adopted by the river and harbor act of March 2, 1827, provided for a pier extending outward from the west shore of the indentation and a detached breakwater parallel with the pier and about 2,000 feet from the city front. An opening between the two structures provided a harbor entrance through which a channel leading to the docks was to be deepened to 13 feet. By 1832, $28,439.84 had been expended on this project, and the breakwater was then 2,564 feet long and the pier 1,400 feet long. In 1848 the breakwater was demolished.

In 1854 a project was prepared by a board of Engineers which provided for three separate breakwaters extending on a line from Light-House Point to Battery Point in 18 feet of water, estimated cost $192,600.81. (Annual Report for 1866, p. 155.) This estimate was increased in 1857 to $401,818.66. Very little work was done under this project, about 250 feet of the western breakwater having been constructed.

A modification of project was recommended in 1866 (Annual Report for 1866, p. 155) to return to the original plan for the harbor, but modifying it by throwing the breakwater outward a little and prolonging it eastward to the 9-foot curve. Appropriation for the work was made by the river and harbor act of March 2, 1867, and the construction of the breakwater was started in 1868.

On August 1, 1868, the removal of the old breakwater was authorized by the Chief of Engineers (Annual Report for 1868, p. 195), and its removal was completed in 1871.

A board of Engineers was convened in 1870 to consider the improvement of the harbor. The board recommended the reconstruction of a dummy crib as a day beacon, and the construction of a breakwater 2,860 feet long, 2,300 feet of which was to be nearly

Digitized by Google

parallel with the shore and 560 feet nearly parallel with the axis of the entrance channel. An entrance channel 170 feet wide was to be dredged to a depth of 13 feet. The estimated cost was $331,000. (Annual Report for 1871, p. 216.) This project was approved November 30, 1870. Between 1870 and 1896 about $313,000 was expended.

The project adopted by the river and harbor act of June 3, 1896, provided for the completion of the breakwater as before planned by the addition of 360 feet to its eastern end and adding the channel arm, 560 feet long, and in addition thereto dredging the entrance channel 170 feet to 350 feet wide and a harbor basin about 2,400 feet long and 1,000 feet wide to a depth at mean lake level suitable for vessels drawing 16 feet. The estimated cost was $408,258.50. The work was completed in 1898 at a cost of $389,060.55.

8. HARBOR AT BUFFALO, N. Y.

The original project for improvement of Buffalo Harbor was adopted by the river and harbor act of May 20, 1826, in accordance with a plan printed in 1824, which provided for rebuilding the north pier and repairing the south pier at the mouth of Buffalo Creek. These piers, which were constructed at the expense of the citizens of Buffalo and the State of New York at a cost of about $15,000, were then stone-filled pile structures, the north one being about 1,000 feet long and the south one about 1,300 feet long.

Appropriations for completing and repairing the piers and dredging channel between them were made by river and harbor acts of 1828–1834, aggregating $124,594; by river and harbor acts of 1838–1844, under which about $50,000 was expended; and by act of 1874, $20,000. The entrance channel was dredged and the north pier repaired, and the south pier was repaired, rebuilt with stone superstructure or mole, and extended by timber cribwork lakeward to its present length of 1,760 feet. Out of funds appropriated, the south pier was repaired and maintained and finally repaired in permanent concrete form in 1900–1901; but maintenance of dredging this channel was done by the city of Buffalo, and the north pier was maintained by the Delaware, Lackawanna & Western Railroad Co.

The river and harbor acts of June 6, 1900, and June 13, 1902, made special provision for deepening the entrance to Buffalo River and the City Ship Canal.

The river and harbor act of June 25, 1910, provided for the removal of the Watson elevator site on certain conditions, at estimated cost of $62,205.

Under these provisions the following work was done: Dredging of the entrance channel from the breakwater to the north pier at the mouth of the river, a distance of 3,000 feet, to a depth of 23 feet at mean lake level for a width of 300 feet; also for a distance of 1,240 feet up the river to a depth of 23 feet to the junction of Buffalo River and the City Ship Canal, with width of 180 feet at outer end of north pier increasing to 250 feet at inner ends of piers and to 720 feet in the basin 850 feet long at the junction of City Ship Canal. Cost, $116,254.57.

Constructing concrete superstructure on 1,424 linear feet of the south pier in 1900–1901, at a total contract cost of $57,579.14.

Digitized by Google

Constructing concrete superstructure on the outer 335 feet of the south pier to replace old timber superstructure, at a total cost of $11,320.25.

Removing Watson elevator site at the junction of the Buffalo River and City Ship Canal, a triangular area with a base of 220 feet and a length of 370 feet. It was purchased by the city of Buffalo and turned over to the United States on condition that it be dredged to a depth of 23 feet, at mean lake level, to provide a turning basin for vessels. This work was done at a cost of $49,124.39, including office and engineering expenses.

The north pier was rebuilt in timber form in 1868–1870, by the Delaware, Lackawanna & Western Railroad Co., and has since been maintained by that company under its occupation of the pier with a coal shipping trestle. During the time the railroad company has had practically the exclusive use of the pier.

A history of this occupancy and copies of official documents relating thereto are given in the report for 1889, pages 2373–2383, and in the report for 1898, page 2775, et seq.

Sea wall.—The act of July 7, 1838, appropriated $40,000 for beginning a masonry sea wall to be 6,740 feet long on sand beach along the lake shore south from Buffalo River entrance channel. Appropriations for continuing construction and repair were made 1844–1866, aggregating $123,301.37. After 5,721 feet had been constructed the work was abandoned in 1866 and the remaining funds, $23,485.04, were reappropriated for Buffalo Harbor by act of June 10, 1872.

Sand-catch pier.—Adopted by river and harbor act of June 23, 1874. A stone-filled pile pier, jutting out into the lake from the sand beach, 1½ miles south of Buffalo River, was built 870 feet long, 10 feet wide and 6 feet high above water in 1874–1876, and extended to the established pierhead line, under the river and harbor act of June 3, 1896, to its total length of 1,148 feet, at a cost of about $25,000.

Construction of outer breakwater and harbor.—Plans of a board of engineers, 1868, to form and protect an outer harbor by construction of 4,000 linear feet of breakwater in 27 feet of water, beginning in the prolongation of the south pier line, 2,500 feet lakeward from the lighthouse thereon and extending thence southerly parallel with the shore, were adopted by river and harbor act of June 23, 1866, $100,000, and continued under appropriations made by river and harbor acts of 1867–1874, aggregating $605,000. Under modified plans of board of engineers, 1874, the length was increased to 7,600 feet and provision made to construct a shore arm to connect with the sand-catch pier. On plans of board of engineers, 1886, to reconstruct superstructure with masonry and concrete, under appropriations 1875–1894, aggregating $1,777,500, 3,800 linear feet of original timber superstructure was replaced with masonry and concrete on the old section of the present breakwater, 7,608 feet long. Of the shore arm, 1,150 feet was built, but was destroyed by storm in 1893. The wreckage was removed in 1898.

A new project was adopted by the river and harbor act of June 3, 1896, based on the plans of a board of engineer officers, and consisted of the abandonment of the shore arm and the extension of the breakwater to Stony Point.

Digitized by Google

The report of the board and details of its plans are published in the Annual Report of the Chief of Engineers for 1895, pages 3153 et seq. The river and harbor act added to the project of the board by providing for the construction of a further length of the sand-catch pier, extending it to the established pierhead line.

Appropriations for the authorized breakwater extension were made by sundry civil acts of 1897–1902, aggregating $2,121,494.

The sundry civil act of March 3, 1905, and the river and harbor act of March 2, 1907, provided funds aggregating $195,842 to build an arm 1,000 feet long to the Stony Point section of breakwater for the purpose of protecting the south harbor entrance, and the river and harbor act of February 27, 1911, provided that $15,000, or so much thereof as may be necessary, from funds previously appropriated, may be applied to the completion of the Stony Point Breakwater arm.

The river and harbor act of March 2, 1907, appropriated $345,000 for the repair and rebuilding of breakwaters damaged by storm in January, 1907.

The river and harbor act of March 2, 1907, made special provisions for dredging at the entrance to canals at south end of the outer harbor to 23 feet depth, for excavating rock shoals outside of the north entrance to the depth of 23 feet.

The river and harbor act of June 25, 1910, made special provision for further removal of shoals outside of the north entrance.

The work done resulted in an outer harbor 4½ miles long, 1,600 feet wide, and 23 feet deep at mean lake level, protected by a breakwater system affording northerly and southerly entrances.

The southerly entrance is 600 feet wide and not less than 28 feet deep at mean lake level, and the northerly entrance 800 feet wide and in course of being deepened to 25 feet at mean lake level.

The breakwater system is 23,600 feet long and comprises 8.894 linear feet of timber-crib-concrete type, 8,259 feet of stone or rubble-mound type, 2,633 feet of timber-crib-stone type, and 3,823 feet of timber-crib type.

Construction of south entrance channel arm.—Sundry civil act of March 3, 1905, $143,506; river and harbor act of March 2, 1907, $52,336. Length, 1,000 feet, running in a northwesterly direction from the north end of the Stony Point section, at an angle of 150° from that section, and built of stone. This was raised to a height of 12 feet below mean lake level with stone deposited by contractors for excavation in Lake Erie entrance to Black Rock Harbor and Erie Basin under contract terms, and the work above this level was done under contract. The work was commenced in 1906 and completed in 1911, at a total cost of $189,154.74. The result of the work was to provide shelter for that part of the harbor injuriously affected by waves coming through the south entrance to the harbor.

Excavation of rock shoals outside north entrance.—(See Annual Report, 1911; river and harbor act of June 25, 1910, $37,400.) To be removed so as to make an available depth of 23 feet at mean lake level. Work was begun under contract in 1912 and completed June 4, 1913, 20,028 cubic yards, scow measure, rock having been excavated, at a total cost of $37,400, including office and engineering expenses.

Digitized by Google

This work accomplished the removal of the northerly half of the shoal area (600 feet long and 300 feet wide) of bedrock, its center lying about 1,000 feet due west of the north end of the old breakwater.

5. BLACK ROCK HARBOR AND CHANNEL, N. Y.

The original improvement of this harbor by the General Government was authorized by the river and harbor act of March 2, 1829, which appropriated $30,000 for extending the pier of Black Rock Harbor at the outlet of Lake Erie to a point opposite Bird Island. Additional appropriations aggregating $22,098 were made and the amounts expended in continuing the work between 1829 and 1834, after which no further work was done until the adoption of the present project.

7. TONAWANDA HARBOR AND NIAGARA RIVER, N. Y.

The original appropriation for the improvement of Tonawanda Harbor and the adjacent portion of Niagara River was made by the river and harbor act of March 3, 1881. (Annual Report for 1881, p. 2426 et seq.) The project provided for the removal of bars in the channel between Tonawanda Island and the mainland and the removal of submerged rocks in the Niagara River channel adjacent to Tonawanda Island, in order to provide a depth of 13 feet at low water, the estimated cost being $15,000. This work was completed in 1881, at a cost of $5,000.

8. NIAGARA RIVER, N. Y.

The first work done for the improvement of this portion of the river was under a project adopted by the river and harbor act of July 13, 1892. (Annual Report for 1892, pages 2541 et seq.) It provided for securing a channel 200 to 400 feet wide and 8 feet deep at mean river level from Tonawanda to Port Day by rock excavation, and for the construction of an embankment from Conners Island to Port Day. The estimated cost was $257,829. No work was done on this project.

The project was modified by the river and harbor act of August 18, 1894 (Annual Report for 1893, p. 3113), to provide a channel 200 feet wide and 12 feet deep at low water from Tonawanda to Schlossers Dock, foot of Sugar Street, which is located about 2,000 feet above Gill Creek and is the port of Niagara Falls. The estimated cost of the work was $95,000. The improvement required a cut through two shoals, one a short distance above Conners Island and Schlossers Dock and the other about halfway between Cayuga Island and Tonawanda; also the removal of scattered bowlders above Cayuga Island. The Conners Island cut was completed, but the Cayuga Island cut, through rock, was not excavated to full width, the work having been stopped in December, 1900, when funds were exhausted.

The river and harbor act of June 25, 1910, provided for completion of the channel across Cayuga Island Shoal to a width of 200 feet and depth of 12 feet at mean river level, at a cost of $10,000, in accordance

Digitized by Google

with plan printed in House Document No. 75, Sixtieth Congress, first session. The work was completed in 1911.

The expenditures under these projects amounted to $68,507.24.

9. HARBOR AT OLCOTT, N. Y.

The original project was adopted by the river and harbor act of March 3, 1867, and provided for a channel 11 feet deep and 150 feet wide between parallel piers about 200 feet apart from deep water in Lake Ontario to deep water in Eighteen Mile Creek. The estimated cost of the improvement was $117,927.

In 1872 the project was modified to provide for the removal of rock in the channel between the piers. (Annual Report for 1872, p. 248.) The piers were completed in 1873—the east pier 851 feet long and the west pier 881 feet long of timber-crib type, and by 1876 the channel had been dredged to a depth of 12 feet at low water, and a width of 115 feet. The amount expended on this work was around $111,000.

In 1891 the project was modified to provide for a depth of 13.5 feet at mean lake level from Main Street bridge to deep water in the lake, the channel to be 180 feet wide between the piers, narrowing to 98 feet at the bridge. No estimate of the cost of this modification appears in the records. The project was completed in 1892, at a cost of $15,213.48, and Olcott was dropped from the list of improvements, a balance of $4,465.35 being returned to the United States Treasury in January, 1896.

Under an appropriation of $15,000 for "continuing improvement" (not based on any recommendation from the War Department) by the river and harbor act of June 13, 1902, the channel which had shoaled to 8 feet at low water, 10.4 feet at mean lake level, was redredged in 1903, 140 feet wide for the entire length between the piers and 100 feet wide for a length of 200 feet south from the inner ends of the piers. This redredging was done to a depth of 13.5 feet at low water, practically 16 feet at mean lake level. Olcott was again dropped from the list of improvements in 1906, and a balance of $13.13 returned to the Treasury.

10. HARBOR AT CHARLOTTE, N. Y.

The original improvement was authorized by the river and harbor act of March 2, 1829. The project provided for securing a channel 12 feet deep across the bar by constructing parallel piers about 450 feet apart, extending to the 12-foot contour in the lake in order to confine and direct the action of the spring freshets. The estimated cost was $53,919.16.

In 1834 the east pier had been extended to a length of 2,847 feet and the west pier to a length of 2,876 feet, and a channel 15 feet deep had been obtained, the total expenditure having been $91,161.05. Between 1835 and 1882 about $241,000 was expended in the maintenance and repair of the piers and in the reconstruction of such parts as had been destroyed by storms.

A new project, based on the recommendation in the Annual Report of the Chief of Engineers for 1881, page 2437, was adopted by the

Digitized by Google

river and harbor act of August 2, 1882. It provided for obtaining a depth of 15 feet by extending the two piers a total distance of 3,250 feet and by dredging, the estimated cost being $154,000. From the adoption of this project to June 30, 1896, about $190,000 was expended, $77,235 for the extension of the piers a distance of 1,444 feet, and the remainder for dredging and repair of piers. The project was modified by authority of the Chief of Engineers July 18, 1896, to preserve the depth by dredging without further extension of the piers for the present, and by authority of the Chief of Engineers March 2, 1897, it was again modified to obtain and maintain not less than 16 feet and not more than 16½ feet at low water in a channel not more than 200 feet wide.

11. HARBOR AT PULTNEYVILLE, N. Y.

The original project was adopted by the river and harbor act of July 11, 1870, and provided for protecting the approach to the creek by building two piers of timber cribs in the lake, about 200 feet apart, and for dredging a channel from the 10-foot curve in the lake to the mouth of the creek, the channel to be 10 feet deep at low water, at an estimated cost of $59,000. This estimate was increased in 1875 to $71,000, due to the hardness of the material dredged.

By 1883 the piers had been extended to their present lengths, the west pier 910 feet and the east pier 572 feet. Dredging was done in the channel in 1873, 1875, and 1880 to secure the required depth, but, due to the washing of sand from the harbor beach, the channel was not permanent and shoaled rapidly.

In 1884 a sheet-pile pier 500 feet long was proposed to be constructed at the eastern side of the entrance to the creek for the purpose of stopping this sand drift. The estimated cost of the pier, with the necessary dredging to restore the 10-foot channel depth, was $30,000. A length of 200 feet of the pier was built in 1891 and 1892.

In 1899 and 1900 the channel was redredged to a depth of 8 feet at low water and a width of 20 feet. This work exhausted the available funds and no further work was done until 1907.

12. HARBOR AT GREAT SODUS BAY, N. Y.

The original project for improvement of this harbor was adopted by the river and harbor act of March 2, 1829, and provided for narrowing the entrance to the bay by constructing two converging breakwaters extending outward from the shore—east breakwater 1,400 feet and west breakwater 2,200 feet long—and for securing the channel by extending parallel piers about 500 feet apart northward from the ends of the breakwaters. The estimated cost was $71,931.26. Under appropriations made from 1829 to 1833, amounting to $77,230, the breakwaters, 640 feet of the west pier and 80 feet of the east pier, were built, as well as a jetty 150 feet long, extending southeasterly from the angle of the east pier. It was found that the channel could not be obtained without dredging, and in 1833 an estimate of $20,000 was made for securing by dredging a channel 1,500 feet long, 150 feet wide, and 15 feet deep. (See Annual Report for 1874, p. 253.)

Digitized by Google

From 1834 to 1838 appropriations amounting to $60,790 were made, under which the piers were completed and dredging operations were carried on.

Between 1838 and 1866, $15,000 was appropriated and expended in the repair of the piers.

The project was modified by the river and harbor act of June 23, 1866, to extend the west pier and dredge the channel to 12 feet depth, estimated at $120,806. (Annual Report for 1866, pp. 171, 173, 174.) Under this project the west pier was extended 130 feet, and during the period from 1866 to 1881 about $191,000 was expended in dredging in the channel and repairing the piers. In 1880 the structures were reported to have the following lengths: West breakwater, 2,200 feet; east breakwater, 1,590 feet; west pier, 1,400 feet; east pier, 940 feet. It was also reported that the channel had shoaled to such an extent that the depth was no greater than before the improvement was commenced in 1829.

13. HARBOR AT LITTLE SODUS BAY, N. Y.

The original project for improvement was adopted by the river and harbor act of August 30, 1852, and work was begun in 1854. A survey had been made in 1829 and a project prepared to close one of two openings into the bay by a dike and, at the other opening, to construct two parallel piers, each 870 feet long, extending into the lake, the estimated cost being $32,327.59. In 1853, when a new survey was made, it was found that the bar between the openings had been swept away, but it was determined to construct the piers as originally planned and connect their inner ends to shore by breakwaters. After 240 feet of the west pier had been constructed and connected with shore by riprap, at an expense of about $10,000, work was suspended in 1856, due to lack of funds. An appropriation of $33,840.41 having been made by the river and harbor act of June 23, 1866, a project was prepared by Lieut. Col. Blunt to extend the west pier out to a depth of 12 feet at low water, to connect it with the west shore by riprap or otherwise, and to dredge a channel 400 feet wide and 12 feet deep at low water, the inner end on the east side to be connected with shore by riprap. The estimated cost was $80,000. By the close of 1868 the west pier was completed to a length of 800 feet, 650 feet of crib work, connecting the west pier with shore, had been constructed, and a channel 200 feet wide and 8 to 15 feet deep had been dredged.

In 1871 Maj. Bowen proposed the construction of an east pier 500 feet long and 250 feet from the west pier, with a breakwater 1,800 feet connecting its inner end to shore, the estimated cost being $62,100. (Annual Report for 1871, p. 234.)

Under appropriations made from 1871 to 1880, aggregating $110,000, the east pier was constructed to a length of 512 feet and the breakwater to a length of 1,524 feet. In addition, repairs were made to pier and dredging was done when necessary.

14. HARBOR AT OSWEGO, N. Y.

The original project for the harbor was adopted by the river and harbor act of March 2, 1827, and provided for building across the

Digitized by Google

cove at the mouth of the river a timber-crib breakwater, with an opening to provide an entrance from the lake into the cove. This breakwater was completed in 1829, the westerly arm being 1,170 feet long with a shore return 260 feet long, and the easterly arm 570 feet long, the opening between them being 350 feet in width.

The project was modified by the river and harbor act of March 2, 1831, to provide for a mole and pierhead outside the west breakwater for its protection, at an estimated cost of $12,720. Between 1831 and 1866, under appropriations aggregating $275,083.84, work on the mole was prosecuted until 1838, when it was abandoned; masonry superstructure was placed on 500 feet of the breakwater, a lighthouse was built, and the breakwater was repaired and rebuilt as necessary.

By the river and harbor act of June 23, 1866, a modification was adopted, which provided for dredging the harbor to a depth of 12 feet, at an estimated cost of $100,000 to $120,000. (Annual Report for 1866, pp. 56, IV, 169.) A further modification adopted by the river and harbor act of July 25, 1868, provided for the extension of the lighthouse pier 500 feet into the lake; estimated cost, $50,000. The dredging was completed in 1869 and the pier in 1870; length 437 feet. The total expenditure on the harbor to this time was $479,-162.87, of which $41,000 was for dredging, the remainder having been expended on the pier and breakwater.

The river and harbor act of July 11, 1870, adopted a new project which provided for forming an outer harbor by building an outer breakwater 5,800 feet long to be located nearly parallel to the old west breakwater and 1,100 feet from it, the estimated cost being $1,161,682. This project was completed in 1881, the timber-crib breakwater as constructed having a lake face 4,870 feet long, a westerly shore return 916 feet long, and an easterly return 246 feet long, the total length being 6,032 feet. The amount expended from 1871 to 1881 was $832,910.09, of which a portion was applied to the maintenance of the old and new breakwaters.

A modification of project was adopted by the river and harbor act of March 3, 1881, and provision was made for the construction of an east breakwater 2,700 feet long, an opening of 350 feet to be left between it and the west breakwater for the passage of vessels; estimated cost $287,000. (Annual Report for 1879, p. 1734.) A length of 248 feet of this breakwater was constructed in 1881, but was removed in 1889.

In 1882 the project was modified to provide for building 300 linear feet of spurs to the lake arm of the outer breakwater as wave breakers; estimated cost $60,000. (Annual Report for 1882, pp. 2451–2452.) Two spurs which were 100 and 150 feet long, respectively, were built in 1885 and 1889, at a cost of $46,786.64. The former was 250 feet from the east end and the latter 2,600 feet from the west end of the breakwater.

The sundry civil act of March 3, 1893, authorized the expenditure of the unexpended balance of the appropriation made July 13, 1892, for this harbor for rock excavation in the mouth of the Oswego River, and the river and harbor act of August 17, 1894, appropriated $10,000 for the same purpose. These amounts were applied to the excavation and the rock removed to the depth of 15 feet from Schuy-

Digitized by Google

ler Street 340 feet upstream to a line 80 feet downstream from the north line of Seneca Street. The cost was $18,172.75.

15. HARBOR AT CAPE VINCENT, N. Y.

The original project was adopted by the river and harbor act of June 3, 1896, and provided for the construction of a breakwater 1,600 feet long, parallel to and 600 feet from the railroad wharf, at an estimated cost of $320,000. No construction work was done under this project, a survey having indicated that a better foundation could be obtained and the breakwater more cheaply constructed if built at a distance of 500 feet from the railroad wharf. (Project printed in Annual Report for 1889, p. 2433.)

16. HARBOR AT OGDENSBURG, N. Y.

The improvement of this harbor was begun in 1868 under provisions of the river and harbor act of March 2, 1867. The original project was to dredge to a depth of 12 feet at low water (1) the channel of the Oswegatchie River below the Lake Street bridge between the wharf lines; (2) along the wharves a mile below; (3) a channel 150 feet wide along the city front connecting these localities; (4) a channel 300 feet wide across the shoal between the channels of the St. Lawrence and Oswegatchie Rivers, and to build, if necessary, 5,500 linear feet of piers, at an estimated cost of $100,000. (Annual Report for 1868, p. 271.) The piers were never built. The dredging was completed in 1876 at a cost of about $107,000.

The project was modified by the river and harbor act of August 2, 1882, to provide for dredging the upper entrance channel from the St. Lawrence River channel across the shoal to and into the mouth of the Oswegatchie River to 16 feet at low water, at an estimated cost of $76,000. (Annual Report for 1882, p. 2461.) On account of the quantity of hardpan encountered, the estimate for this project was increased to $108,000. (Annual Report for 1885, p. 2295.) The amount expended on dredging under this project was $51,000.

The project adopted by the river and harbor act of September 19, 1890, provided for dredging all the channels to a depth of 16.5 feet below the zero of the Ogdensburg gauge (15 feet below zero of the Oswego gauge), at an estimated cost of $158,950. (Annual Report for 1890, p. 2872.) This project was modified by authority of the Chief of Engineers February 27, 1897, to deepen the two lower entrance channels to 16 feet below the zero of the Oswego gauge, and by the river and harbor act of March 3, 1899, further modified to dredge 900 feet of the channel along the city front above Franklin Street to but 14 feet below the same zero, the projected depth of the upper channel to and into the mouth of the Oswegatchie River up to the bridge, and the balance of the channel along the city front to remain 15 feet. This project was completed in July, 1903, at a cost of about $111,000.

Digitized by Google

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE LOS ANGELES, CAL., DISTRICT.

1. SAN DIEGO HARBOR, CAL.

The project, authorized by act of August 30, 1852, appropriated $30,000 to build a levee across the mouth of the San Diego River and turn it into its former channel into False Bay. Shortly afterwards the embankment or levee built by this appropriation was carried away in a freshet, and the river resumed its old course into San Diego Bay.

The river and harbor act of March 3, 1875, appropriated $80,000 for the diversion of the river. (See S. Doc. No. 25, 41st Cong., 2d sess.) An earthen dike 7,735 feet long, faced on the river side with rubble stone, was completed in 1876 at a cost of $79,798.72. Repairs to this dike made with later appropriations (not including appropriation of 1890) have brought this cost up to $81,918.45. Some repairs have also been made by the city of San Diego.

The river and harbor act of September 19, 1890, authorized the maintenance of the dike, the construction of a jetty 7,500 feet long on Zuninga Shoal, with a view to securing a depth of 26 feet on the outer bar, and dredging the middle ground channel, with a view to securing a channel 500 feet wide and 24 feet deep at mean lower low water. (See H. Doc. No. 177, 50th Cong., 1st sess.) This project was completed in February, 1905, at a total cost of $543,293.23. Repairs were made to the dike at a cost of $4,913.58; a rubble stone jetty 7,500 feet long was built on Zuninga Shoal to the height of extreme high water; a channel 26 feet deep and 271 feet wide (28 feet deep over a width of 171 feet) was dredged through the outer bar; and a channel 26 feet deep and 400 feet wide was dredged through the middle ground.

The river and harbor acts of March 3, 1905, March 2, 1907, and March 3, 1909, appropriated in all $60,000 for maintenance of the outer bar channel. The amount expended in this work was $59,904.21.

The river and harbor act of June 25, 1910, appropriated $125,000 for dredging through the outer bar a channel 600 feet wide and 30 feet deep at mean lower low water, and through the middle ground a channel 30 feet deep at mean lower low water, and 400 feet wide at its southerly end, and to widen out at the northerly end in order better to accommodate vessels using the United States Navy coaling station at La Playa. (See H. Doc. No. 961, 60th Cong., 1st sess.) This project was completed in May, 1912, at a cost of $124,703.68. A channel 600 feet wide and 30 feet deep (32 feet over a width of 300 feet) was dredged through the outer bar, and a channel 30 feet deep and of a width increasing from 700 feet at the south end to 1,000 feet at the north end was dredged through the middle ground.

2. LOS ANGELES HARBOR, CAL.

OUTER HARBOR.

The original project was authorized by the river and harbor act of June 3, 1896, which directed the appointment of a board to con-

Digitized by Google

sist of an officer of the Navy, an officer of the Coast and Geodetic Survey, and three civil engineers, and authorized the Secretary of War to make contracts for the completion of the improvement of the harbor selected by the board, according to the project reported by the board, at a cost not exceeding in the aggregate $2,900,000. The board recommended the construction of a breakwater at San Pedro Bay, and estimated that a breakwater 8,500 feet long could be built for the amount authorized. (See S. Doc. No. 18, 55th Cong., 1st sess.) Work on the breakwater began in April, 1899, under continuing contract, and was completed in September, 1910. A rubble-mound breakwater 9,265.5 feet long, 20 feet wide, and 14 feet high at mean lower low water was built, at a cost of $2,830,406.54, including $35,555.76 expended by the board. Above the low-water plane the breakwater consisted of two walls of roughly rectangular stone laid in courses and filled between with rubblestone. At the outer end of the breakwater was a concrete block 40 feet square and 20 feet high.

The extension of the breakwater to the shore was authorized in river and harbor act of June 25, 1910. (See H. Doc. No. 969, 60th Cong., 1st sess.) Work on the breakwater extension under contract began in April, 1911, and was completed in December, 1912. The extension, 1,887 feet long, 15 feet wide, and 14 feet high at mean lower low water, was built of rubblestone, at a cost of $208,296.52. In addition to the $178,000 appropriated by act of June 25, 1910, $30,296.52 was expended from the balance of the $2,900,000 appropriated for the construction of the breakwater authorized by act of June 3, 1896.

INNER HARBOR.

The original project, authorized by river and harbor act of March 3, 1871, contemplated gaining a depth of 10 feet at mean lower low water at the entrance to the harbor "by connecting Rattlesnake and Deadmans Islands in a manner to compel the tidal currents to follow a defined channel." (See Annual Report for 1873, p. 1129.) As the work progressed the project broadened to include the construction of a jetty on the westerly side of the entrance channel and dredging the reef at the entrance. The depth of 10 feet having been obtained in 1881, the river and harbor act of August 2, 1882, and later acts, provided for continuing the improvement by raising the jetties and by dredging with a view to obtaining a depth at the entrance of 15 feet. The east jetty was extended from Rattlesnake Island to a point 425 feet south of Deadmans Island, a distance, including Deadmans Island, of 7,560 feet. For 3,700 feet of the length it is built to the height of 9 feet above mean lower low water of sheet piling reinforced on the ocean side with rubblestone, and for 2,425 feet farther it is built of rubblestone 10 feet wide on top and 10 feet high at mean lower low water. The west jetty was built of rubblestone from Timms Point, a distance of 3,400 feet, to its full height of 10 feet above mean lower low water and 10 feet wide, and 300 feet additional to ordinary high water. A channel 16 feet deep was obtained at the entrance. Work began in October, 1871, and was completed in November, 1893, at a cost of $954,497.68.

Digitized by Google

The river and harbor act of June 3, 1896, provided for further improvement by dredging a channel 400 feet wide and 18 feet deep from San Pedro Bay to the lower end of the wharves, and along the harbor fronts to the upper end of the wharves to a depth of 20 feet at mean lower low water, together with repairs to the east jetty. The estimated cost of this work was $392,725. (See S. Doc. No. 61, 53d Cong., 3d sess.) Due to a proviso forming part of the act, no work was done.

The river and harbor act of June 13, 1902, provided for dredging a channel 20 feet deep and 400 feet wide from the outer harbor to the foot of the wharves, and 24 feet deep between harbor lines from the foot of the wharves to and including the turning basin 1,600 feet in diameter just below Mormon Island. It also provided for repairs to the east jetty and for the construction of a dike to divert the waters of the Los Angeles River from Wilmington Lagoon. (See H. Doc. No. 357, 56th Cong., 1st sess.) The same act made available the $50,000 appropriated by the act of June 3, 1896. The original estimated cost of the work, including the procurement of a dredging plant, was $550,000. This estimate was later increased to $663,000. On account of changed conditions the dike was not built. A portion of the east jetty was reinforced with rubble stone at a cost of $3,700. The 20-inch suction dredge *San Pedro*, with the necessary discharge pipe, floating plant, etc., was built at a cost of $118,721.78. A channel was dredged to a width of 400 feet and a depth of 21 feet at mean lower low water (except for a short distance abreast of Deadmans Island, where the depth was only 20 feet) from the outer harbor up to the lower end of the wharves. From this point up to and including the turning basin, 1,600 feet in diameter, a total distance of 16,000 feet, the channel was dredged to a depth of 25.5 feet and to the full width between wharves. The project was completed in June, 1910, at a cost of $674,948.09.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE FIRST SAN FRANCISCO, CAL., DISTRICT.

---

1. SAN FRANCISCO HARBOR, CAL.

San Francisco Harbor has a broad and deep entrance and a good depth over the bar across the entrance, as well as very extensive areas of deep water within the harbor, so that in its natural condition the only improvements necessary were to remove the most dangerous submarine rocks scattered about the harbor and the surrounding bay.

The first of these rocks to receive attention was Blossom Rock, lying about half way between Alcatraz Island and Yerba Buena, or Goat, Island, two prominent and well-known landmarks in the vicinity. The project for the removal of this rock was adopted in 1868 and contemplated its removal to a depth of 24 feet at mean lower low water, involving the removal of about 5,000 cubic yards of rock. This work was done by contract and was completed in 1870 at a contract price of $75,000.

Digitized by Google

In 1874 a project was adopted for the removal of Noonday Rock, a small pinnacle of rock about 3 miles northwest of the North Farallones and about 25 miles west of the entrance to the Golden Gate. The work was done by contract at a price of $20,000. In examining the rock with a diver before commencing operations the contractor discovered a large cavity within the rock. A heavy charge of high explosive was placed in this cavity and the rock was removed with one blast to a depth of 48 feet at mean lower low water. This work was done in 1875. (Annual Report for 1875, p. 719.)

In 1872 a plan was adopted for the removal of Rincon rock, lying on the water front of the city of San Francisco and adjacent to the wharves. The work was done by contract, but the blasting interfering with structures in the vicinity, the work was abandoned before entirely completed and the contractor paid $39,483.88 for the work actually done. A total of about 4,000 cubic yards of rock was removed. This work completed all the work contemplated by previous projects in this locality.

2. REDWOOD CREEK, CAL.

The river and harbor act of July 5, 1884, adopted a project for improving Redwood Harbor, Cal., so as to provide a depth of 3 feet, no width being stated. This work was commenced in 1886 with a Government dredge, and depths of from 2 to 3 feet were obtained, with widths of from 50 to 60 feet. The work was continued thereafter from year to year and extended down the creek itself. The work was completed in 1889. Redredging was resorted to at irregular intervals, the channel being subject to considerable deterioration annually.

The river and harbor act of June 13, 1902, adopted a project contemplating a new channel 5 feet deep and 100 feet wide through the middle ground in the creek; dredging in front of the city wharf at Redwood City, Cal., building a dam of sheet piling across a navigable slough; and constructing a dike of timber and brush near but outside of the foot of the channel. The estimated cost was $8,400. This work was done by contract in 1903, but the dike and dam referred to above were not constructed because of the interference with free tidal movement. (Annual Report for 1911, p. 966.)

3. OAKLAND HARBOR, CAL.

Pursuant to the river and harbor act of March 3, 1873, a board of engineer officers made a survey of Oakland Harbor and formulated the original project for its improvement to meet the needs of navigation and commerce. This project provided for two parallel mid-tide training walls, 1,000 feet apart at the entrance, estimated to cost $401,550; a tidal basin at the upper end, estimated to cost $799,525; a canal 8 feet deep and 300 feet wide connecting this basin with San Leandro Bay, estimated to cost $349,497; a dam 4 feet above low water across the mouth of San Leandro Bay, estimated to cost $65,010, and designed to make San Leandro Bay serve as an auxiliary tidal basin; and dredging a channel between the jetties 100 feet wide and 6 feet deep at low water, estimated to cost $33,990. To provide

Digitized by Google

for contingencies 10 per cent was added to each of the above items. (Annual Report for 1874, pt. 2, pp. 382, 383.)

It was expected that the above works would scour and erode a channel about 500 feet wide and 18 to 20 feet deep between the jetties and in front of Oakland.

It was estimated that it would take 30 years to complete the project, and operations were carried on with that time limit in view. Some features of the project were largely experimental in design, and as the work progressed considerable deviation from the original plans was found necessary to cope with the exigencies encountered. The necessary changes were made accordingly and in an informal way.

The two training walls were constructed first, work being begun in 1874, but the city of Oakland having previously dredged an entrance channel it was necessary to change their positions to accommodate the dredged channel, and on account of trouble with owners of submerged land it was not possible to place them 1,000 feet apart. As they did not produce the desired effect, they were raised and made into high-water jetties. The channel between the jetties was dredged in 1881 and 1882, the width being increased to 300 feet and the depth to 14 feet in the center and 10 feet on the sides.

In 1874 dredging was begun in the tidal basin by the hydraulic-dredge process. It may be interesting to note that the first hydraulic dredge ever constructed was used on this work, although it had been previously used on the San Joaquin River, and it was on this work that the first ladder dredge was used. As the sole object was to secure increase of tidal prism, only soft material was dredged, and no attempt was made to produce a channel.

In the meantime the excavation of the canal had been delayed on account of the difficulties of securing a right of way. The appropriation for this part of the project stipulated that local interests should furnish land for the right of way free of cost to the United States, and the county provided the necessary funds, but the condemnation proceedings were so long drawn out that the county diverted its funds to other purposes.

In the meantime experience with the tidal scour indicated that the canal was not necessary, and it was recommended that it be omitted from the project, but as Congress had provided the money for its excavation it was deemed imperative to include it. Work was not commenced until the United States provided the necessary funds, which was in 1889. The width of the canal was changed to 400 feet. In addition, the United States constructed three highway bridges across the tidal canal and dredged the outlet of Sausal Creek, not originally contemplated in the project.

The deepening effect expected from the tidal scour did not materialize, and it was found necessary to dredge the channel in front of Oakland in order to secure sufficient depths. As time passed, further dredging was done in the jetty channel also in order to secure the depths originally contemplated.

The dam across the mouth of San Leandro Bay was never constructed.

Tidal scour has had practically no effect on the project. As there are no streams emptying into the harbor, silting is not excessive.

The first formal modification of the project is found in House Document No. 262, Fifty-sixth Congress, second session (Annual

Digitized by Google

Report for 1901, pp. 3448, 3449), which presented three alternate plans. By the river and harbor act of June 13, 1902, a modification of the project was authorized, but without specifying which one of the three plans the funds should be applied to. The river and harbor act of March 3, 1905, officially designated plan No. 3 as the approved modification. This plan provided for a channel 500 feet wide and 25 feet deep from San Francisco Bay to Chestnut Street, a channel 300 feet wide and 25 feet deep from Chestnut Street to Fallon Street, a channel 300 feet wide and 17 feet deep from Fallon Street to the tidal basin, a channel 300 feet wide and 12 feet deep completely around the tidal basin, and the extension of the south jetty; estimated to cost $968,203.

By special restriction, however, in the river and harbor act of March 3, 1905, the channel between San Francisco Bay and Chestnut Street, for which funds were therein authorized, was limited to a width of 300 feet. The act of March 2, 1907, further modified the project by providing for extension of south jetty 500 feet, widening to 500 feet the channel 25 feet deep from San Francisco Bay to Fallon Street, deepening to 25 feet the channel 300 feet wide from Fallon Street to the tidal basin, deepening to 17 feet the channel 300 feet wide around the north side of the tidal basin to the tidal canal and from the tidal canal along the Alameda shore to Tenth Avenue. The estimated cost was placed at $1,468,203. Before this project was completed the present project was adopted by the act of June 25, 1910.

4. SAN PABLO BAY, CAL.

This is a large body of water lying between Suisun Bay on the north and San Francisco Bay on the south. It is used by vessels plying to the several industrial centers along the eastern shore as well as to the few creeks and sloughs emptying into the bay, but the principal trade route is to Port Costa, the great California grain port, and Mare Island Navy Yard. Across this route there lies a shoal 5 miles in width, known as Pinole Shoal.

The river and harbor act of June 13, 1902, adopted the original project for a channel across this shoal 300 feet wide, 30 feet deep, with a length of about 5 miles, at an estimated cost of $381,000, with $16,000 estimated as cost of annual maintenance. (See H. Doc. No. 89, 56th Cong., 1st sess.) This work was undertaken in 1903 by contract, but the contractor defaulted and it was subsequently relet to another contractor and finally completed in 1906.

The excavation at this locality is easy but the difficulties of disposing of the material are unusually great. Some of the material was placed behind an impounding bulkhead, but as that method proved too expensive the greater portion of the material was dumped in deep water within the bay. It did not remain where dumped, however, but was carried by the currents onto the flats along the northwest shore of the bay, where natural agencies are causing gradual shoaling.

Owing to the soft material, deterioration of this improvement was rapid and the channel was totally obliterated in a short time, but the general depth over the shoal remained greater than it was before the improvement was undertaken.

Digitized by Google

Originally the main object to be obtained by this improvement was to permit Navy vessels to reach Mare Island Navy Yard, but the rapid increase in size and draft of Navy vessels in the past 15 years has been such that it now requires a 40-foot channel for the larger type of Navy vessels, and the result has been that Mare Island Navy Yard is counted upon as available only for the lighter-draft vessels. The rapid growth of shipping from San Pablo Bay points in the meantime has developed an amount of commerce that warrants and requires a deep-water channel at this locality.

6. PETALUMA CREEK AND NAPA RIVER, CAL.

(*a*) PETALUMA CREEK.

This waterway drains an area of 83 square miles, mostly agricultural land; consequently there are large quantities of detritus brought down with the annual rains and deposited in the channel. In its natural condition the creek was very crooked at the upper end and dry at low water.

The original project was adopted by the river and harbor act of June 14, 1880, and contemplated dredging to obtain a depth of 3 feet and making three cut-offs in the upper part of the creek just below the town of Petaluma. (Annual Report for 1880, p. 2243.) Work was commenced in 1880 under contract and was continued from year to year and finally completed in 1884 at a total cost of $27,676. The three cut-offs were made and the channel dredged to a width of 50 feet and depth of 3 feet up to within 2,600 feet of Petaluma; thence to the head of navigation it was made 40 feet wide and 2 feet deep. (Annual Report for 1884, p. 2198.)

Due to the rapid silting, the channel was redredged from time to time with a Government dredge, and in 1892 the project was modified so as to dredge a channel with a Government dredge and make it as deep as funds would permit. As a result of this work the channel was first dredged to 4 feet depth in the lower part of the improved section and 3 feet depth in the upper part. It was again dredged with a Government dredge in 1896 and made 50 feet wide and 6 feet deep up to within 1 mile of Petaluma, and thence to the head of navigation it was dredged the same width but the depth gradually reduced to 4 feet. (Annual Report for 1896, p. 3206.)

Silting in this stream being rapid, almost annual dredging is necessary to keep a ship channel open to the head of navigation.

8. HUMBOLDT HARBOR AND BAY, CAL.

(A) REBUILDING JETTIES.

In 1876 consideration was given this locality as a site for a harbor of refuge, but it was rejected because of the great cost of constructing the two parallel jetties at the entrance which was reported as the only practicable means of improvement. In 1881 its claims for national aid in the development of a commercial port were first brought forward. The commerce of the locality then was small and hardly warranted the heavy expense of the necessary jetties, but the great natural resources of the immediately surrounding country and its isola-

Digitized by Google

tion from the rest of the State by high mountain barriers, together with the fact that there was no other seaport on the Pacific coast within hundreds of miles, combined to force engineers to find some method for improving the condition of the entrance channel.

Humboldt Bay itself is a narrow body of water running parallel to the coast line and separated from the ocean by a narrow strip of sand. An opening about 2,000 feet in width through this sand strip forms a natural entrance to the bay. The tidal discharge through this outlet is 100,000 second-feet and the cross-sectional area is about 50,000 square feet with depths of from 60 to 70 feet. Under natural conditions this channel spreads out in crossing the bar and shifts considerably from a southwest to a northwest direction, and for brief periods of time during the cycle of changes it had a straight course to sea, but the depth varied greatly, being as much as 25 feet at times when the channel was running southwest and as low as 9 feet as it shifted toward the north. The tendency of the tidal scour is toward the southwest, and these changes in direction of the channel are caused by the prevailing southwest storms driving sand from the beach and bar on the south toward the north, forcing the channel northerly until the outer segment has a direction about parallel to the coast. When the limit of movement in this direction has been reached a new outlet breaks through to the southwest and the cycle of changes repeats itself. A favorable feature is that the outfall of the bar channel is upon an ocean bed which rapidly increases in depth.

The original project was adopted by the river and harbor act of July 5, 1884, and provided for the construction of a single low-water jetty starting from the south spit and running in a northwesterly direction for 5,000 or 6,000 feet, with a top width of 20 feet and suitable side slopes. The idea of this jetty was to intercept the movement of sand toward the north. The estimated cost of the work was $600,000 and work was begun under contract in May, 1889. The jetty was built by the trestle method with a brush mattress 4 feet thick as a foundation, with rubblestone forming the mass of the jetty. (Annual Report for 1900, p. 4237.) The first effect of this work was to cut away the north spit. In one year the low-water width of the entrance, which was 2,100 feet at the beginning of the work, had increased to 3,500 feet. These changes were so marked that the project was modified so as to provide for shore-protection work on the north spit and the construction of a second jetty starting from the north spit and running seaward nearly parallel to the south jetty, both jetties to extend out to the 18-foot contour and both to be raised to slightly above the plane of high water, so as to confine the tidal flow straight out to sea. The width of the jetty top was changed to 10 feet and the height of the crest changed to 8 feet above low-water level. The projected direction of the south jetty was changed to a more nearly westerly course and its length was increased to 7,800 feet, the north jetty to be 6,750 feet in length, and their seaward ends to be about 2,100 feet apart. The average depth of water in which the jetties were to be built was taken as 12 feet. The width of the jetty base varied from 45 to 60 feet, according to the depth of water. The estimated cost of the entire work under modified project, including shore protection, was $2,057,615. (Annual Report for 1891, p. 3129.)

Digitized by Google

Work was begun under contract in May, 1891, on this modified project. The entrance, having increased in width to 5,000 feet, more than double its original width, the first work was for shore protection on the north spit, consisting of brush mats covered with rock. Thereafter work was continued on the north jetty, and it was completed in April, 1897. Work was then resumed on the south jetty, and it was completed in August, 1899.

In the course of construction it was found that the sand spits piled up on the outer side of the jetty, but on the channel side the current scoured the sand out, so as to seriously endanger the foundation of the jetty. This difficulty was overcome by the construction of spurs, or groins, at selected points along the channel side.

As completed the north jetty had a total length of 8,068 feet and a crest height varying from 5 to 10 feet above mean lower low water for about 5,000 feet of its length from shore. For the next 2,000 feet its crest height varied from 3 to 5 feet above low-water level, and the outer 1,000 feet sloped from low-water level to a depth of 12 feet below this plane at the outer end. The south jetty had a total length of 7,408 feet, with a crest height of 10 feet above low-water level for 6,560 feet from shore, thence gradually sloping in the next 800 feet to a depth of 8 feet below low water. The outer end of the jetty was 28 feet below low water.

The slopes on the outer ends of the jetties were apparently made to reduce the quantities of stone used and keep the work within the estimated cost.

Notwithstanding the fact that the jetties were not built to the full height contemplated by the project, yet they proved very effective in the direction desired and produced a channel 30 feet deep, 600 feet wide, straight to sea. The cross section used, however, was too light to withstand the violence of the heavy seas prevailing in this locality and the jetties deteriorated rapidly. Upon the completion of the jetties all work was abandoned and no effort made to repair the damage of the successive winter seasons. In a comparatively short time the effective outer ends had practically disappeared and the unfavorable conditions of the bar channel reappeared practically as they existed originally in the natural state.

The experiences with these two jetties seems to indicate that only very substantially built jetties can be expected to be reasonably permanent in this locality and that regular maintenance work with timely repairs of damage done by winter storms is more economical in the long run than abandonment of all work upon first completion of the jetties.

(B) CHANNEL IN FRONT OF EUREKA.

The river and harbor act of March 3, 1881, adopted a project for this locality, but apparently without any well-defined limits for the channel proposed. A channel 10 feet deep, 350 feet wide, had been suggested, together with additional channels to Arcata and Hookton within Humboldt Bay. (Annual Report for 1881, p. 2485.) Work was begun under contract in 1881 and a channel dredged 10 feet deep, 240 feet wide, 4,100 feet long in front of Eureka. (Annual Report for 1882, p. 2540.) In 1883–84 this channel was deepened to 13 feet, 150 feet wide for a distance of 1,150 feet, 100 feet wide for an addi-

Digitized by Google

tional distance of 1,230 feet, and 50 feet wide for a farther distance of 830 feet.

The cost of the above work can not be definitely determined, because it was done in connection with other work at the entrance to Humboldt Bay, but the original estimate was 35 cents per cubic yard for dredging; the first contract price was 25 cents per cubic yard and the second contract price 48 cents per cubic yard.

In 1898 this project was modified so as to provide a channel 200 feet wide, 15 feet deep, 8,900 feet long, at an estimated cost of $75,000. (See H. Doc. No. 528, 55th Cong., 2d sess.) The work was begun under contract in 1899 and completed in 1900, at a cost of $50,000.

This locality is not subject to very much deterioration, so that improvements are fairly permanent, but occasional dredging at intervals of 7 or 8 years is necessary for maintenance.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENTS UNDER THE SACRAMENTO-FEATHER RIVER BOARD.

---

1 SACRAMENTO AND FEATHER RIVERS, CAL. (GENERAL IMPROVEMENT).

The first appropriation for the Sacramento and Feather Rivers was made March 3, 1875. It was to be used for "extracting snags in the Sacramento River and for the improvement of the Feather River by removal of snags and by construction of brush jetties." (Annual Report for 1875, pt. 2, p. 696.) This was the original project for this improvement.

This project was modified by the river and harbor act approved August 7, 1882, in accordance with House Document No. 98, Forty-seventh Congress, first session, which provided for restraining barriers (for mining débris) in the Yuba, Bear, and American Rivers and for dredging in the Sacramento and Feather Rivers. (Annual Report for 1882, p. 2533.)

The project was further modified by the act approved December 21, 1889, which made the balance to the credit of the Sacramento and Feather Rivers immediately available for expenditure in improving navigation by repairing damages caused by floods. (Annual Report for 1890, p. 2912.)

The project was again modified by the river and harbor act approved July 13, 1892, in accordance with House Document No. 246, Fifty-first Congress, second session, which contemplated a permanent annual appropriation of $25,000 for improvement by the use of snagboat and crew in the Sacramento River above Sacramento, a specific appropriation of $275,000 for the removal of obstructions in the Lower Sacramento, and $25,000 for the closure of Jacob's break; a specific appropriation of $300,000 for treatment of the Yuba River near and above Marysville and a "specific annual expenditure of $20,000 for improvement of the navigable channel of the Feather River."

Although slight additions to this modification and changes in estimates have been made by later acts, the project has not been mate-

Digitized by Google

rially altered since, nor any of its provisions rescinded by Congress. The act which became a law August 18, 1894, added to the project the treatment of the Bear River and authorized a cut-off on the Feather River to avoid Shanghai Bend.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE FIRST DISTRICT, PORTLAND, OREG.

---

1. COQUILLE RIVER, OREG.

The original project for improving Coquille River, Oreg., was adopted by the river and harbor act of June 14, 1880, and provided for the construction of two converging high-tide jetties of rubble-stone, 800 feet apart, so located as to cause the river to empty into the sea about one-half mile north of its original mouth, these jetties to run to sea a sufficient distance to create and maintain a channel 12 feet deep at low tide. The estimated cost was $164,200. In 1880 the proposed depth was reduced to 10 feet, in 1888 to 8 feet, and on May 8, 1891, the plan was changed to provide that the jetties should be 600 feet apart at their outer ends instead of 800 feet. In 1892 the length of the north jetty was limited to 1,575 feet and that of the south jetty to 2,700 feet, while the estimated cost of completing the improvement, including the previous appropriations, amounting to $105,000 (and including the $6,883.90 expended in removing snags in the river between Coquille and Myrtle Point under river and harbor acts of Aug. 11, 1888, and Sept. 19, 1890), was increased from $164,200 to $283,018.04. (Annual Report for 1892, p. 2664.)

The river and harbor acts of August 11, 1888, and September 19, 1890, in making appropriations for continuing the work of improvement at the entrance to the river, authorized the expenditure of $5,000 and $3,000, respectively, in removing snags in the 12 miles of the upper portion of the river between Coquille and Myrtle Point, and $6,883.90 was so expended.

During the latter part of the fiscal year 1906 it became apparent that the available balance would not complete the north jetty, as the bed of the ocean was scoured away along the jetty from a depth of 4 or 5 feet to a depth of 14 to 16 feet at low tide, and on May 8, 1906, the estimated cost of completing the project, not including expenditures for maintenance, was increased to $306,200.

Jetty construction was commenced in 1880 and completed in 1908, when the north jetty was extended to its project length of 1,575 feet. The south jetty reached its project length, 2,700 feet, in 1890.

The total amount expended under this project was $351,192.75, of which $302,841.68 was for jetty construction, $6,883.90 for snagging the river, and $41,467.17 for maintenance.

Both jetties are of high-tide rubblestone type, with their sea ends 600 feet apart. They have caused the channel to straighten and locate away from dangerous rocks, and have increased the low-water depth on the bar from 3 feet to 10 feet. The mean range of tide is about 4.2 feet at Bandon, near the mouth. Coasting vessels can ascend the river to Coquille, about 25 miles above Bandon. Above

Digitized by Google

this point the channel is available for smaller craft for a farther distance of 12 miles, or to Myrtle Point.

2. ENTRANCE TO COOS BAY AND HARBOR, OREG.

The scope of previous projects for the improvement of the entrance to Coos Bay and Harbor, Oreg., is as follows:

The original project, adopted by the river and harbor act of March 3, 1879, provided for the construction of a half-tide jetty from a point inside the entrance about 250 yards below Fossil Point on a line toward the east end of Coos Head, the structure to be of wood and stone, or stone, as should be found best, at an estimated cost of $600,000. The object of this jetty was to prevent accretion to the south end of the sand spit on the north side of the entrance and to open and maintain a deeper and more direct channel across the bar. A total of $213,750 was expended on this project and 1,761 feet of jetty constructed, when operations were suspended, July 21, 1890.

The second project, adopted by the river and harbor act of September 19, 1890, provided for increasing the depth across the bar to 20 feet by the construction of a north jetty 9,600 feet long and a slightly converging south jetty 4,200 feet long, leaving an entrance width of about 1,500 feet, at an estimated cost of $2,466,412. The project also included the reclamation and holding of the sands of the North Spit.

The projected depth was obtained by the construction of 9,520 feet of north jetty which was completed in 1894. From 1894 to 1901 work under this project consisted of the restoration of jetty enrockment which had been beaten down by the sea. Jetty work was discontinued in March, 1901, and in 1909 the balance of the appropriation ($23,920.49) was applied to dredging the inner harbor as authorized by the river and harbor act of March 3, 1909. The total expenditure under this project is $721,720.76 of which $524,999.44 was for jetty construction, $172,800.83 for maintenance of jetty and other charges, and $23,920.49 for dredging in the inner harbor. In addition to the foregoing United States funds local interests expended $21,270.41 for dredging.

The reclamation of sand dunes of North Spit was commenced in 1891 by planting 3 acres with Holland grass roots (*Arunda arenaria*). This work is in progress a portion of each year. At the end of the fiscal year 1914 about 720 acres of sand wastes of the North Spit had been reclaimed in this manner. The grass thrives and is very effective in holding the drifting sands. To date the total expenditure for this work is about $7,200. (For information regarding reclamation of sand dunes, see Annual Report, 1890, p. 2947.)

The third project, adopted by the river and harbor act of August 18, 1894, provided for the construction of a small dipper dredge and two hopper scows to be used in dredging a channel 10 feet deep at mean lower low tide and 100 feet wide at the bottom through Marshfield and Isthmus Slough Shoals at an estimated cost of $27,390.

The river and harbor acts of August 18, 1894, and June 3, 1896, making appropriations for dredging Coos Bay, were amended by the sundry civil act of July 1, 1898, so as to dispense with the necessity of constructing the dredge and scows and permitted the work to be done by contract or otherwise. Conditions having changed con-

Digitized by Google

siderably between 1894 and 1898 the project was modified August 16, 1898, to provide for dredging such shoals and removing such obstructions in the upper part of the bay as constituted obstructions at that time instead of limiting the work to dredging. As the result of information obtained from a detailed survey of the north and west shores only, it was decided to dredge a channel 150 feet wide on the bottom and 13 feet deep at mean lower low water through Hogsback, Webster Point, and Stave Mill Shoals, and 100 feet wide at the bottom and 13 feet deep at mean lower low water through Bunker Shoal.

Dredging was commenced in 1899 and completed the same year, most of the work being done under contract. At the close of operations a least depth of 13 feet at mean lower low water had been obtained. After the completion of dredging shoals in Coos Bay, a shoal at the mouth of Pony Slough developed which made it necessary for loaded vessels to lighter in order to cross it. Allotments were made of $10,000 from the river and harbor act of June 6, 1900, and $3,500 from the river and harbor act of June 13, 1902, for removing this shoal. The work was completed during the fiscal year 1904–5, and a further allotment of $5,000 was made on May 17, 1905, for redredging the shoal opposite Marshfield. These latter funds were expended during the fiscal year 1906 in dredging the channel to a depth of 13 feet throughout the entire length of the shoal. This work was commenced in September and completed in November, 1905.

The amount expended on dredging in Coos Bay since the adoption of the project of 1898 amounts to $45,426.51, of which $18,570.72 was for maintenance. The project was finally completed and the balance on hand, $473.24, returned to the Treasury in 1906, as the maintenance of the channel was made a part of the improvement of Coos Bay and Harbor (general improvement).

4. MOUTH OF SIUSLAW RIVER, OREG.

The original project for improving the entrance to Siuslaw River, Oreg., was adopted by the river and harbor act of September 19, 1890, which provided for the construction of two high-tide stone jetties, converging until the distance between them is about 500 feet, and then, if necessary, running out to sea parallel to each other for a sufficient distance to open and maintain a channel over the bar with a depth at low water of at least 10 feet. The estimated cost of constructing 4,400 feet of north jetty and 3,800 feet of south jetty was $280,190. (See Annual Report for 1891, p. 3174.) This estimate was found inadequate and it was decided to suspend work until Congress could be informed of the facts. A board of engineers was accordingly appointed to formulate a plan and make a new estimate of its cost. Upon recommendation of this board the project was modified in 1891 to provide for the construction of two high-tide rubblestone jetties so located as to direct the currents on the ocean bar practically perpendicular to the coast, the jetties to converge until they are 600 feet apart at the crest of the bar; the north jetty to be 4,500 feet long with a 3,000-foot tramway approach to a wharf located under Cannery Hill, and the south jetty to be 3,200 feet long with a 2,400-foot tramway approach to a wharf located opposite Cannery Hill. By these jetties it was proposed to fix the bar chan-

Digitized by Google

nel in its most desirable location and to increase the depth to 8 feet at mean low tide. The project also provided that the north jetty should be constructed first, at least in part. The estimated cost of the work was $700,000, with no provision for maintenance.

Preliminary work was commenced in 1891 and active jetty construction in 1893. To June 30, 1901, the north jetty, including the tramway approach, had been completed for a distance of 4,090 feet, at a total cost of $151,700.83 for original work and $10,611.27 for maintenance, surveys, etc. This work resulted in somewhat checking the tendency of the bar channel to shift its position as far north as often occurred before the improvement was commenced. No work was done on the south jetty.

The river and harbor act of June 13, 1902, directed that a reexamination and survey be made of the river at its mouth and of the shoals near Florence, with a view to the adoption of a project to provide for its commerce at a less cost than the existing project. The Board of Engineers for Rivers and Harbors, to which the report was referred, reported March 26, 1903, that in its opinion it was not desirable to continue the improvement of the Siuslaw River with the view of obtaining a depth of 8 feet. Upon recommendation of the Chief of Engineers the Secretary of War suspended operations pending receipt of further instructions from Congress. Nothing was done during the fiscal year 1904. The river and harbor act of March 3, 1905, provided that the unexpended balance of appropriations should be returned to the Treasury, except that an amount might be retained sufficient for maintenance for two years. In accordance with this act construction work was discontinued and the serviceable plant distributed among other works. The stipulated period of maintenance (two years) having elapsed the balance remaining unexpended, $24,838, was returned to the Treasury in 1908 and the work abandoned.

6. TILLAMOOK BAY AND BAR, OREG.

The original project for the improvement of Tillamook Bay and Bar was adopted by the river and harbor act of August 11, 1888, which provided for a survey of the entrance and for the improvement of Dry Stocking Bar and Hoquarten Slough by building dikes, at an estimated cost of $5,200 and $150 annually for maintenance.

Operations were commenced in 1890, and during the year 1,148.5 feet of sheet pile dikes and 448.5 feet of pile and brush revetment work were built at Dry Stocking Bar, but the unprecedented freshets of the following winter and spring swept them away, so no results can be claimed for the work done. During that year a survey of the bar and entrance was made, and Hoquarten Slough was cleared of snags as far as Tillamook City. A survey of the entrance to Tillamook Bay was made in July, 1891, and the report thereon (see H. Doc. No. 35, 52d Cong., 1st sess.) formed the basis for a new special project. The total amount expended on the foregoing work is $5,700, of which $964.45 was applied to maintenance.

The second project, adopted by the river and harbor act of July 13, 1892, provided for connecting the north and middle channels nearly opposite Bay City, on the north shore of Tillamook Bay, putting in dikes at Junction and Dry Stocking Bars, and contemplated a

Digitized by Google

least depth of 9 feet at mean high tide from Hobsonville to Tillamook on Hoquarten Slough, at an estimated cost of $100,000. No provision was made for maintenance at this time, but in 1903 it was estimated that $10,000 would be required biennially to maintain the work. At this time it was also estimated that $6,000 would be required to make certain changes in and additions to the plant.

Preliminary operations were commenced in 1892 and actual construction in 1893. In 1895 the project was somewhat modified by providing for different works which were believed essential to accomplish the desired end. The estimated cost remained as originally stated. The expenditures to June 30, 1897, $52,221.86, resulted in cutting a navigable channel through the sand and mud flats separating Bay City Channel from Garibaldi Channel, and in the following work designed to increase the flow and depth of water in Garibaldi Channel and Hoquarten Slough so as to aid vessels to reach Tillamook City: The removal of snags and overhanging trees in Hoquarten Slough as far up as Tillamook City; the construction of a dike across the head of Middle Channel; a dike across lower mouth of Kilchis River; a dike across the head of Old South Channel; a dike across the lower mouth of Wilson River; a dike at Dry Stocking Bar; a dike across the head of South Fork of Trask River; a dike across the North Fork of Trask River; and excavating a channel from the North Fork of Trask River to Hoquarten Slough, by means of which the waters of both forks of Trask River are emptied into Hoquarten Slough above Dry Stocking Bar. The foregoing work was done under contract. In 1899 operations consisted of keeping dikes free from drift and in preparing for active operations as soon as funds were made available. In 1900 a snag scow, constructed under contract at a total cost of $2,720.90, including equipment, was placed in commission and operated by hired labor. During the year it removed snags from the Hoquarten Slough Channel between Tillamook and Bay City, and dredged a 10-foot channel through Dry Stocking Bar and through a shoal in the channel opposite the old mouth of Wilson River, and at the close of the year was engaged in widening the channel opposite Bay City.

Several spur dikes were also constructed under contract, the brush mattresses and rubblestone filling therefor also being supplied under contract. Miscellaneous repairs to dikes were also made. It was estimated that the various dikes and improved channels could be made practically permanent at a cost of $27,000. The operations during 1901 were in continuation of those in progress at the close of the previous fiscal year, and consisted of dredging shoals and constructing deflecting dikes in and along the selected channel leading from Hobsonville to Tillamook City. A channel having the least depth of 9 feet at mean high tide from Hobsonville to Tillamook, as called for by the project was obtained, and the project completed in 1901. This work was discontinued August 18, 1913, as the maintenance of this channel by local interests was made a condition of the present project.

The total amount expended under this project to the end of the fiscal year 1915 was $143,007.39, distributed as follows: $72,473.37 for original work and $70,534.02 for maintenance, of which $476.95 was expended during 1915 in caring for Government plant.

Digitized by Google

7. NEHALEM BAY, OREG.

The original project for improvement of Nehalem Bar and entrance to Nehalem Bay, Oreg., was adopted by the river and harbor act of September 19, 1890, which appropriated $10,000 for "commencement of jetty construction." The plan of improvement upon which this appropriation was based was to build two high-tide stone jetties converging until the distance apart is about 500 feet, and then, if necessary, running out to sea parallel to each other to such distance as will insure a low-water depth on the bar of at least 8 feet, the north jetty to rest on the end of the sandy peninsula and the south jetty upon the mainland, the object being to hold the channel in its northerly position. The estimated cost of this work was $325,927.50.

As the amount of money appropriated was inadequate to commence operations, nothing was done except to make a reexamination of the harbor, plan, and estimates, which resulted in increasing the estimated cost to $712,388 in 1891. The amount expended for this work is $415.08. The balance of the appropriation was returned to the Treasury July 22, 1892, to be available whenever the work started.

The river and harbor act of June 2, 1896, directed that a preliminary examination be made "for modified plan, to be paid for out of money on hand." This survey was made in 1897 at a cost of $270.60 and resulted in an unfavorable recommendation (Annual Report for 1898, p. 3009), after which the question of improvement appears to have been abandoned until the adoption of the present project by the river and harbor act of July 25, 1912.

Operations under this project were confined to the two surveys mentioned. The total amount expended for this work is $685.68. The balance of the appropriation, $9,314.32, was returned to the Treasury.

8. SNAKE RIVER, OREG, WASH., AND IDAHO.

The improvement of Snake River has been associated with that of the Columbia River above Celilo Falls from 1876 until 1907, but no formal project for the Snake River was adopted by Congress prior to 1902.

The project for the improvement of the Columbia River was begun in 1872, and in 1876, $15,000 was appropriated by Congress for the improvement of Columbia and Snake Rivers. Of this appropriation about $12,000 was spent at Pine Tree Rapids, on the Snake River, and in 1877 a project was formulated for the improvement of the upper Columbia and Snake Rivers. The project low-water depth was 5½ feet on the Columbia River and 4½ feet on the Snake River. Under this project very little work was done on the Columbia River, nearly all the money being spent on Snake River in removing rocks and bowlders from the channel under contract, at prices varying from $12 to $24.75 per cubic yard. Work was confined to the stretch of river between Riparia, Wash., and the mouth of the river, a distance of 67 miles. All work previous to 1885 (except some work done at Umatilla Rapids in 1877) was done by contract. In 1885 a system of work was begun by the purchase of materials and hired labor, and this method, with few exceptions, has since been followed.

Digitized by Google

Work under the project of 1877, by contract and day labor, below Riparia is as follows:

Locality.	Solid rock removed.	Locality.	Solid rock removed.
	Cu. yds.		*Cu. yds.*
Texas Rapids	2,538	Simmons Rapid No. 15	31
Palouse Rapids	1,610	Copleys Cut-off	11
False Palouse Rapids	9	Fish Hook Rapids	524
Monumental Rapids	137	Five Mile Rapids	423
Pine Tree Rapids	2,152		

In 1884 operations began on the river above Riparia, and work was done at Bishops Bar, Granite Point, Log Cabin Rapids, Little Goose Island, Deadmans Gulch, Almota, Kellys Bar, Truax Landing, and Little Pine Tree Rapids. A total of 416 cubic yards of solid rock and bowlders were removed.

Upon the completion of the railroad from Portland, Oreg., to the Snake River at Riparia, in 1888, river navigation was practically suspended below Riparia, and the work of improvement was confined to the river above Riparia.

In 1892 a project was submitted for the construction of dikes and removal of bowlders between Riparia, Wash., and Lewiston, Idaho, at an estimated cost of $29,226. Two dikes were constructed under this project, one at Goose Island and one at Log Cabin Rapids, and some rocks were removed from the channel.

There was expended on the projects previous to the adoption of the present project $168,500, of which $15,089.74 was applied to maintenance.

In addition to the foregoing, some work was done freeing the river of obstructions between Huntington, Oreg., and the Seven Devils mining district. This work began in 1892, and in 1896 all of the Government plant on this portion of the river was sold and the river improvement abandoned. The estimated cost of this work was $80,000, and there was expended $40,500 on the project, with the removal of about 4,000 cubic yards of rock, when the work was abandoned as not worthy of further improvement.

9. COLUMBIA RIVER AND TRIBUTARIES ABOVE CELILO FALLS TO THE MOUTH OF SNAKE RIVER, OREG. AND WASH.

The first allotment, $25,000, for improving Columbia River from Celilo Falls to Snake River was made in 1867 and was used in making an examination and survey in September, 1867, and in experimental blasting in 1868 to determine the cost and advisability of undertaking improvement by this method. A 7-foot channel through John Day, Indian, Squally Hook, Umatilla, Rock Creek, and Homly Rapids was recommended, at an estimated cost of $132,328, with no provision for maintenance. This plan was adopted by the river and harbor act of June 10, 1872, which appropriated $50,000 for the improvement. The following quantities of solid rock were removed under contract:

Digitized by Google

Locality.	Quantity.	Locality.	Quantity.
	Cu. yds.		*Cu. yds*
Umatilla Rapids	1,051	Homly Rapids	118
John Day Rapids	900	Owyhee Rapids	67
Devils Bend Rapids	94		
Squally Hook Rapids	308	Total	2,598

The contract price of this work varied from $50 to $24.75 per cubic yard.

A total of $105,000 was appropriated and expended on this project in addition to the allotment of $25,000 made in 1867.

The river and harbor act of August 14, 1876, appropriated $15,000 for the improvement of upper Columbia and Snake Rivers, which is the first money appropriated for improving Snake River. Of this amount about $12,000 was spent on Pine Tree Rapids, in Snake River. The project was modified in 1877 to include Snake River, and, as modified, the project of 1877 contemplated a low-water depth of 5½ feet in the Columbia and 4½ feet in the Snake, at an estimated cost of $132,000 for improvement. No provision was made for maintenance. Very little work was done on the Columbia River under this project, as the railroad from The Dalles, Oreg., to Wallula, Wash., along the south bank of the river, was completed in 1880, which reduced the importance of the river as a carrier and navigation was then practically suspended. At Homly Rapids 156 cubic yards of rock and at Umatilla Rapids 100 cubic yards of solid rock was removed. All subsequent work under the project was done on the Snake River, and work on the Columbia River was not resumed until the adoption of the present project by the river and harbor act of March 2, 1907.

10. COLUMBIA RIVER BETWEEN THE FOOT OF THE DALLES RAPIDS AND THE HEAD OF CELILO FALLS, OREG. AND WASH.

The first project was adopted by the river and harbor act of August 18, 1894, which appropriated $100,000 for the construction of a boat railway from the foot of The Dalles Rapids to the head of Celilo Falls, at an estimated cost of $2,264,467, including open river improvement of Threemile Rapids. An additional appropriation of $150,000 was made by the river and harbor act of June 3, 1896. Up to June 30, 1899, no actual construction work for a boat railway had been done, but most of the right of way had been secured. It was then reported that the navigation interests preferred a portage railway or a canal and locks. The Secretary of War decided to defer further action in the matter until Congress definitely decided the question of constructing a boat railway.

The river and harbor act of June 6, 1900, provided for an examination of the river between the foot of The Dalles Rapids and head of Celilo Falls with a view to the construction of a canal and locks to overcome the obstructions to navigation.

The report submitted under this act is printed (see Annual Report for 1901, p. 3502, no maps, and H. Doc. No. 228, 56th Cong., 2d sess., containing maps), and proposes the construction of a short canal and locks around The Dalles or Fivemile Rapids, and another around

Digitized by Google

the falls at Celilo, with intermediate river improvement, at an estimated cost of $3,969,371. The river and harbor act of June 13, 1902, adopted the project of improving the river from the foot of The Dalles Rapids to the head of Celilo Falls in accordance with the report, but provided that before entering upon the work an examination should be made by a board of engineers with a view to modifying the project so as to diminish the cost of the improvement.

Detailed surveys, made in 1903 under the direction of a board of engineers, resulted in the recommendation of the present project, which was adopted by the river and harbor act of March 3, 1905.

The amount expended on previous projects prior to the adoption of the present project is $27,112.83.

12. CANAL AT THE CASCADES, COLUMBIA RIVER, OREG.

The river and harbor act of June 23, 1874, contained the following item: "Cascades and Dalles of Columbia, Oregon and Washington, for the purpose of ascertaining the practicability of constructing canals and locks at such points."

A survey and estimate was made in the fall of 1874 for a canal around the Cascades in Oregon 2,600 feet in length, three locks each 40 by 215 feet, lift 7 feet each, draft of boats loaded 8 feet, at a cost of $700,000, including removal of rocks below the canal. The river and harbor act of August 14, 1876, appropriated $90,000 for the construction of a canal around the Cascades of the Columbia River in the State of Oregon.

In 1877 an estimate was submitted for a canal of the following dimensions:

Excavation through the plateau, 3,150 feet.
Crib breakwater 65 feet high from lower end of canal, 4,050 feet.
Total length, including breakwater, 7,200 feet.
Width of cutting at surface, low water, 58 feet.
Depth at low water, 50 feet.
Depth at low water over miter sill, 8 feet.
Depth at extreme high water over miter sill, 68 feet.
Two locks, 46 by 250, 8 feet on sills.
Estimate for canal navigable at all stages, $1,544,545.
Estimate for canal navigable to 25-foot stage, $1,188,860.

On September 24, 1877, the foregoing plans were approved by a board of engineer officers, but a size of 50 by 300 feet was recommended for the locks. In 1878 the width was increased to 70 feet.

Work under this project began in October, 1878, when a contract was let for the excavation of both locks and a part of the canal. The project was modified in 1880 by a board that recommended one lock 462 by 90 feet, to accommodate one towboat and three barges, with lift of about 24 feet and a gate opening of 70 feet. A guard gate was to be provided at the head and foot of the canal. A modification was made in 1888 for lock capacity of 462 by 90 feet in the clear, 8 feet on the sill, with gate span the full width of the lock and lockage to 20-foot stage of river. The upper guard gate was to be placed at a lock's distance above the upper gate to act as an upper gate for a second lock.

Operations had been carried on by hired labor for the canal proper and for open-river work, but some open-river work was done by con-

Digitized by Google

tract. The canal work was suspended for a time to await its effect on the low-water level of the river. Open-river work was practically completed in 1883.

In 1890 plans with revised estimate were submitted. The plans were in accordance with the approved project and the revised estimate of $3,623,000.

The river and harbor act of July 13, 1892, appropriated $326,350 for continuing the canal work and provided for contracts to complete the work. On January 23, 1893, a contract was made for the completion of the work, and hired-labor work was discontinued.

14. COLUMBIA RIVER BETWEEN VANCOUVER, WASH., AND THE MOUTH OF WILLAMETTE RIVER.

The original project for improving Columbia River between Vancouver, Wash., and the mouth of Willamette River, adopted by the river and harbor act of July 13, 1892, provided for constructing a pile, brush, and rubblestone dike about 3,000 feet long, to a height of 4 feet above low water, from the Oregon shore to the head of Hayden Island, opposite Vancouver, in order to stop the flow south of the island during low-water stages, deflect it down the main channel, and scour out the troublesome shoals, and thus provide a channel depth of 20 feet or more. The estimated cost of the improvement was $33,000. No provision was made for maintenance.

The entire amount was appropriated by the river and harbor act of July 13, 1892, and work was commenced the same year. This was continued under contract until April, 1893, when all but 60 feet of the dam, being the portion next to the island, was completed. At this time the river rose, submerging the dam and island, and when the water receded the gap between the island and dam was found to have increased to 470 feet by erosion from the island. The balance of the appropriation then remaining being insufficient to close the gap, no further work was undertaken except to thoroughly revet the head of the island with stone and brush, with a view to preventing further scour, as the island is composed of sand and silt.

This revetment was completed before another rise in the river occurred, but notwithstanding the revetment the erosion continued until in 1895 the gap was 700 feet wide and in the deepest portion had a low-water depth of about 30 feet. (The amount expended on the foregoing improvement to June 30, 1896, was $32,994.80.) This resulted in the project being modified by the river and harbor act of June 3, 1896, which provided for completing the improvement by extending the dam 1,500 feet downstream, thus forming a deflecting dike, the extension to continue 4 feet above low water. The dike work was to be supplemented by dredging the shoals which then obstructed navigation, and thus open a channel 150 feet wide and 20 feet deep at low water. The estimated cost of this improvement was $67,000. No provision was made for maintenance as it was believed the increased current, caused by the deflecting dike, could be relied upon for its maintenance. The river and harbor act of June 3, 1896, appropriated this sum. Nothing was done during the fiscal year 1897, as the river did not reach a stage sufficiently low to permit working on the dam to advantage. On November 16,

Digitized by Google

1897, a contract was entered into for furnishing all labor and materials required to make the necessary repairs to the then existing dam; to construct about 1,500 feet of dam, with its top about 6 feet above low water, from the end of the then-existing dam to the head of Hayden Island; to construct across the head of the island about 700 feet of cross dams from the new portion of the main dam, and to construct about 800 feet of shore revetment at the head of the island. Operations were begun by the contractor December 20, 1897, and completed April 9, 1898. The amount expended for this work was $25,208.83.

Immediately after the completion of the work it was submerged by the usual summer rise in the Columbia River. In October, 1898, after the high water receded, an examination of the head of the island and the main and cross dikes was made, when it was found that all of the main dike, excepting about 500 feet of its downstream (west) end, was in good condition, but that the two cross dikes connecting the head of the island with the main dike had been carried almost entirely away and that a portion of the head of the island had also been carried away. On November 7, 1898, the Chief of Engineers authorized the extension of the main dike downstream (along the north side of the head of the island) about 700 feet, the construction of two cross dikes (of stronger construction than those built in 1897–98) connecting the proposed 700-foot extension of the main dike with the head of the island and the revetment of the head of the island to prevent erosion. The estimated cost of the work was $16,000. Operations under the contract commenced January 24, 1899. As the work progressed it was found that $16,000 would not be sufficient to complete the work, and this estimate was accordingly increased on March 1, 1899, to $25,516, or $9,516 in excess of the former amount.

The usual summer rise in the Columbia River set in immediately after the completion of the work, May 2, 1899, and it remained submerged until the fall of 1899, when an examination was made. This examination disclosed the fact that the shore revetment on the head of the island, designed to prevent erosion, had been only very slightly damaged at an unimportant place by the summer's floods. The main dike and two cross dikes were found to be in as good condition as when completed, May 2, 1899, with the exception that the brush and rubblestone filling in places had slightly settled, permitting the passage of currents through such places, which would cause damage unless stopped. On October 12, 1899, the Chief of Engineers authorized the placing of a small quantity of riprap shore protection on the head of Hayden Island and the placing of additional brush and rubblestone filling in the main and cross dikes to compensate for the settlement that had been caused by the high water of the summer of 1899. Operations under contract commenced November 3, 1899, and were completed March 19, 1900, and resulted in putting all portions of the work in excellent condition.

During September–October, 1899, a survey was made to determine whether the dredging provided for in the project would be necessary and, if so, where it should be done. This survey showed that the slough south of the island had shoaled throughout, and very markedly in many places, at some points as much as 10 feet, with but little change in the main channel north of the island. The effect

Digitized by Google

that the dike had toward scouring a channel 20 feet deep through the obstructing bars north of the island (up to the time the survey was made in 1899) may be said to be but little, if any. However, the dike had been completed only five or six months when that survey was made, and it is not believed, therefore, that the results shown by this survey may be properly accepted as representing the ultimate effect of the dike upon the shoals in the main channel.

The expenditures to June 30, 1900, were $85,533.16 for works of improvement up to May 2, 1899; and $9,007.82 for maintenance of improvement from May 2, 1899, to June 30, 1900; or a total of $94,540.98; and resulted in completing the dike and revetting the head of Hayden Island to prevent erosion.

On June 18, 1901, $8,000 was allotted from the appropriation of June 6, 1900, for emergencies in river and harbor works, to be applied to repairing the dike during the low-water period of the autumn of 1901. The materials were purchased and placed in the work under a contract dated November 8, 1901; operations being completed March 4, 1902, and the dike and revetment left in excellent repair.

During the fiscal year 1903 about 635 cubic yards of rubblestone was placed in the main dike at several places to compensate for settlement caused by the high water of the summer of 1902. The stone was purchased and placed in the dike under an emergency contract.

All work in connection with this project was completed in 1903. The construction work was completed May 2, 1899.

The amount expended under this project, as modified by the river and harbor act of June 3, 1896, was $109,440.99, of which $85,532.16 was for improvement, and $23,908.83 for maintenance. These expenditures resulted in completing the dike and in revetting the head of Hayden Island to prevent erosion. No dredging was done.

The present project was adopted by the river and harbor act of March 3, 1905. (See H. Doc. No. 56, 58th Cong., 2d sess.)

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE SECOND PORTLAND, OREG., DISTRICT.

---

1. WILLAMETTE RIVER ABOVE PORTLAND AND YAMHILL RIVER, OREG.

The original project for improving the Willamette River above Portland (Annual Report for 1871, p. 905), provided for the removal of snags, stumps, bowlders, and overhanging trees, the construction of training walls and the scraping of shoal bars, with a view to rendering possible continuous navigation for light-draft steamboats between Portland and Eugene, 172 miles, at an estimated cost of $16,000. (A canal and locks affording a low-water depth of 3 feet were constructed around Willamette Falls by private enterprise in the years 1870–1872.) The original appropriation under this project was made in the river and harbor act of March 3, 1871. The project was modified by the river and harbor act of July 13,

Digitized by Google

1892, to include removal of obstructions in the Yamhill River to McMinnville on the south fork of the river, 18 miles above its mouth, at an estimated cost of $3,000. Work under this project and its modification consisted largely in removing obstructions as required by the immediate necessities of commerce and resulted in an increase of navigability at all stages. The total expended on this project and its modification was $247,747.51, all of which may be regarded as having been applied to new work.

5. COLUMBIA AND LOWER WILLAMETTE RIVERS BELOW PORTLAND, OREG.

The original project for the improvement of the Columbia and Lower Willamette Rivers from Portland to the sea was approved by the Chief of Engineers May 21, 1877. (Annual Report for 1877, p. 1019.) The first appropriation expended under this project was made in the river and harbor act of June 18, 1878. The project contemplated obtaining a depth of 20 feet at low water by means of dams, dikes, and revetments, and the estimated cost was $298,974. Prior to the adoption of this project funds appropriated by the river and harbor acts of 1866 to 1876, inclusive, were expended in dredging various bars for temporary relief.

This project was modified by the river and harbor act of July 13, 1892 (H. Doc. No. 38, 52d Cong., 1st sess.), to provide for obtaining a channel 25 feet deep at low water at an estimated cost of $772,464. The request of the Port of Portland Commission, a corporation existing under the laws of the State of Oregon, to assist in the work, was approved by the Secretary of War October 19, 1891.

The river and harbor act of June 13, 1902, adopted a further project for securing by contraction works and dredging a 25-foot channel to the sea. (H. Doc. No. 673, 56th Cong., 1st sess., and Annual Report for 1900, p. 4418.) The estimated cost was $2,796,300 (including $175,000 for dredge) and $50,000 annually for maintenance.

The river and harbor act of June 25, 1910, provided that so much of the amount appropriated therein as might be necessary should be expended in dredging the west channel at Swan Island for use of log tows and shoal-water boats. Between April and July, 1911, this channel was dredged to a depth of 8 feet at low water and a width of 300 feet, 772,800 cubic yards of sand and 500 linear feet of the Swan Island Dike being removed, all at a cost of $32,288.40.

Operations by the United States under the original project and its modifications consisted in the construction of dams at Swan Island Chute, Willamette Slough, and other sloughs in the Willamette River near its mouth, and of dikes at St. Helens and Martins Island, of dams at Burke Slough and Martins Slough in the Columbia River, in the construction of bank protection at Coon Island at the mouth of the Willamette, and in dredging. Dredging was done at Flavel, Smith Point, Sylvia De Grasse, Upper Sands, Taylor Sands, Tongue Point (Hogs Back), No. 2 Beacon, Harrington Point, and Pillar Rock Bars in the estuary (13,596,091 cubic yards); Skamokawa, Puget Island, Coffee Island, Eureka, Walker Island, La Du, Slaughters, Rainier, Dobelbowers, Hunters, Martin Island, St. Helens, Henrici, and Willow Bars in the Columbia above the estuary (7,820,808

Digitized by Google

cubic yards), and in the Willamette River at the mouth, Postoffice and Swan Island upper and lower bars (1,894,448 cubic yards); total, 23,311,347 cubic yards.

Operations by the port of Portland under the original project and its modifications consisted in the construction of dikes at St. Johns and Postoffice Bars in the Willamette River and at Walkers Island, Snag Island, and Cathlamet Bay in the Columbia River, and in dredging the channel at Swan Island and Postoffice Bar in the Willamette River and at the mouth of the Willamette, at St. Helens, Martins Island, Walkers Island, and in Cathlamet Bay in the Columbia River. The total quantity of material removed was about 18,187,000 cubic yards.

Operations by the United States and the port of Portland resulted in obtaining from time to time at all the various bars the depths called for by the original project and its modifications respectively. The depths thus obtained were subject to reductions due to the deposit of material by the annual freshets, and the bars had to be redredged periodically for maintenance.

The total expenditure by the port of Portland for dike construction and dredging was about $995,588.

The amount expended by the United States for relief dredging from 1866 to 1876, inclusive, was $221,780.46. The amount expended on the original or 20-foot project (1877–1892) was $649,805.97. The amount expended on the 25-foot project (1892–1912), including $132,284.24 applied to redredging channels and repairing revetments during the fiscal year 1913, was $1,768,020.54. The total amount expended on work under the original project and its modifications, including the amount expended for relief dredging prior to 1877, was $2,639,606.97, of which $1,448,651.45 was applied to new work and $1,190,955.52 to maintenance.

6. MOUTH OF COLUMBIA RIVER, OREG. AND WASH.

The original project (S. Doc. No. 13, 47th Cong., 2d sess., and Annual Report for 1883, p. 2011) was adopted by the river and harbor act of July 5, 1884, and contemplated obtaining a channel across the bar 30 feet deep at mean lower low water by the construction of a jetty 4½ miles in length extending seaward from Point Adams, on the south side of the entrance, and terminating at a point about 3 miles south of Cape Disappointment. The jetty was to rise to the level of low tide and was to be built of rubblestone on a foundation of brush mattress. The point of beginning was about 450 feet north of the northerly salient of old Fort Stevens. The estimated cost was $3,710,000. In 1893 it was decided to raise the jetty to high water at its inner end, sloping thence to elevation 4 feet above mean lower low water at its outer end, and to build four groins from 500 to 1,000 feet in length on the north side of the jetty, as recommended in the report of a board of engineers dated May 27, 1893. (Annual Report for 1893, p. 3489.) Active operations covered the period from April, 1885, to October, 1895. The completed jetty was 4½ miles long, and, including groins and shore protection, contained 945.923 tons of stone. The shore revetment is 3,955 feet long and extends from the root of the jetty along the low-water line of Point

Digitized by Google

Adams to a point about 1,300 feet southeast of the receiving wharves. The total expended on this project was $1,968,753.14 for new work, prior to which $17,500 had been appropriated and expended for survey, etc.

As completed, the profile of the jetty was that recommended by the board of 1893—that is, 12 to 10 feet high above mean lower low water for a distance of 1.8 miles from shore, thence sloping to 4 feet above datum at the outer end. By June 30, 1896, the outer 1,500 feet had been beaten down to low water, and the jetty suffered further damage from time to time until it was rebuilt under the present project.

When work on the south jetty began the best channel across the bar was 20 feet deep and ran nearly north and south through a point about a mile west of the projected outer end of that jetty. As the jetty was extended the channel deepened and shifted to the west. In 1890 the governing depth was 24 feet; in 1891, 28 feet; in 1892, 1893, and 1894, 29 feet; in 1895, 31 feet; in 1896 and 1897, 30 feet; and in 1898, 29 feet. In 1899 it was 28 feet deep and its direction had shifted to the northwest. It continued to shift and to shoal, and by 1902 all traces of a channel had disappeared and a governing depth of 20 to 22 feet was found over the whole westerly and southerly portions of the bar.

7. CLATSKANIE RIVER, OREG.

The original project (H. Doc. No. 218, 55th Cong., 2d sess., and Annual Report for 1898, p. 3049) was adopted by the river and harbor act of March 3, 1899. It contemplated cuttting new channels across two bends and dredging a channel 6 feet in depth at low water, with a bottom width of 40 feet, from the mouth to Clatskanie, about 3 miles, at an estimated cost of $13,000. The work contemplated was completed in 1902, 55,864 cubic yards having been removed. This resulted in giving a depth of 5 feet at low water over the shoalest places and in making the channel shorter by 4,050 feet and easier of navigation. The total expended on this work was $12,675.47, of which $11,807.37 was for new work and $868.10 for maintenance.

8. COWLITZ AND LEWIS RIVERS, WASH.

(A) COWLITZ RIVER, WASH.

The original project (S. Doc. No. 34, 46th Cong., 2d sess., and Annual Report for 1880, p. 2331) was adopted by the river and harbor act of June 14, 1880. It provided for the removal of snags, drift, and other obstructions between the mouth and Cowlitz Landing, now Toledo, 37 miles, at an estimated cost of $5,000 for the first year and $2,000 annually thereafter for maintenance. Operations were carried on under this project between 1880 and 1910, when the present project was adopted, and resulted in obtaining and maintaining a channel 14 inches deep at low water in the shoalest places. The total expended on this work was $53,182.93, of which $4,999 was for new work and $48,183.93 for maintenance.

Digitized by Google

(B) LEWIS RIVER, WASH.

The original project (H. Doc. No. 64, 55th Cong., 1st sess., and Annual Report for 1897, p. 3473) was adopted by the river and harbor act of March 3, 1899. It provided for snagging, dike construction, and dredging, with a view to obtaining a depth of 6 feet at low water between the mouth and the forks, 3¾ miles, and 4 feet in the East Fork to La Center, 6¾ miles above the mouth, at an estimated cost of $20,460 for new work.

This project was modified by the river and harbor act of June 13, 1902, to include the improvement of the North Fork, for which no estimate of cost had previously been made. Operations under the original project and its modifications resulted in a channel about 4 feet deep at low water to the forks, about 18 inches deep from the forks to La Center on the East Fork, 2½ feet deep from the forks to Woodland on the North Fork, and thence 1 foot deep to Runyon, the head of navigation, 23 miles above Woodland. These depths are not materially greater than the original ones, but the channel was made easier of navigation and the navigable period lengthened. The total amount expended was $30,350, of which $22,251.62 was for new work and $8,098.38 for maintenance.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE SEATTLE, WASH., DISTRICT.

---

1. WILLAPA RIVER AND HARBOR, WASH.

This improvement includes Willapa River and Harbor, the North River which enters Willapa Harbor on the north side, and the Nasel River which enters Willapa Harbor on the south side.

The original project for the improvement of Willapa River and Harbor was adopted by the river and harbor act of July 13, 1892, and plan and estimate are published in the Annual Report of the Chief of Engineers for 1891, pages 3264–3271. The project was to provide a channel 100 feet wide and 8 feet deep at low water from deep water in Willapa Bay to Willapa City, a distance of about 24 miles, by dredging at the bars and the construction of dikes across the head of Mailboat Slough, near South Bend, and Lauderbach Slough, near Willapa City, to concentrate the current in the main channel. The act adopting the project appropriated $18,000, the river and harbor act of August 18, 1894, $13,500, and the river and harbor act of March 3, 1899, $5,000 for the work, which was commenced under contract in 1892 and completed in 1896. A channel of project dimensions was obtained.

The river and harbor act of August 18, 1894, authorized the expenditure of not to exceed $2,500 of the appropriation for improving Willapa River and Harbor, Wash., in the removal of a log jam in the North River. A description of the jam is published in the Annual Report of the Chief of Engineers for 1896, pages 3330–3332. This jam was removed by contract in 1896, but re-formed and was again

Digitized by Google

removed in 1897. The accumulation of snags narrowed the channel, and the river and harbor act of March 3, 1899, authorized the expenditure of so much of the balance of appropriation as might be necessary in thoroughly removing the obstruction. This work was done by hired labor in the fall of 1899, and the channel through the jam completely cleared to a width of 85 feet.

The river and harbor act of July 13, 1892, appropriated $1,500 for snagging the Nasel River. This work was done by hired labor and plant, and was completed on September 15, 1892. The river and harbor act of June 13, 1902, authorized the expenditure of any balance available from the appropriation previously made for improving Willapa River and Harbor to snagging or otherwise improving the North and Nasel Rivers. Under this authority the Nasel River was again snagged from its mouth to Nasel Landing.

The river and harbor act of March 2, 1907, adopted the project published in House Document No. 477, Fifty-ninth Congress, first session, which contemplated a channel 150 feet wide and 12 feet deep at mean lower low water through the shoals between South Bend and Raymond, a distance of 3 miles. The estimated cost was $25,000, which amount was appropriated by the act adopting the project. This project was completed by dredging under contract. The work commenced in November, 1907, and was completed in February, 1908.

The amount expended under the above projects was $56,798.44 for improvement and $4,316.02 for maintenance, making a total of $61,114.46. In addition $1,500 appropriated by the river and harbor act of July 13, 1892, for snagging the Nasel River was expended.

On the completion of the projects the available depths at mean lower low water were 16 feet to South Bend, 12 feet to Raymond, and 8 feet to Willapa City. North and Nasel Rivers, which are used mostly for floating saw logs, had been cleared of snags and log jams, and light-draft boats could ascend these streams for varying distances, depending upon the stages of the tides.

3. GRAYS HARBOR (INNER PORTION) BETWEEN ABERDEEN AND THE ENTRANCE TO SAID HARBOR, AND CHEHALIS RIVER, WASH.

The original project for Chehalis River, printed in Annual Report of the Chief of Engineers for 1882, pages 2687–2690, was adopted by the river and harbor act of August 2, 1882, and contemplated the annual removal of snags and log jams as far as Claquato, 82 miles from the mouth. The estimated cost of the first removal was $5,000. Appropriations amounting to $19,000 were made for this work by the river and harbor acts of 1882, 1884, 1886, 1890, 1896, and 1899. The log jams were removed in 1884, and snagging was done by hired labor and plant during low-water stages each season.

The river and harbor act of July 13, 1892, adopted a project for Grays Harbor (inner portion) and Chehalis River (Annual Report for 1891, p. 3297), which contemplated a channel 200 feet wide and 16 feet deep at mid-tide, as far as Montesano, to be secured by dredging the shoals and constructing dikes to concentrate the flow of the river in the north channel. The estimated cost of this work was $150,000. The river and harbor act of July 13, 1892, appropriated $50,000 for this work, and the river and harbor act of 1894, $25,000. Work of dike construction was commenced under contract in 1893

Digitized by Google

and completed in 1895. The work under this project was suspended in 1896, and the balance of the appropriation turned into the Treasury. No dredging was done. The river and harbor act of June 13, 1902, appropriated $50,000, and the river and harbor act of March 3, 1905, $30,000 for continuing the improvement of the inner harbor and Chehalis River and the two projects were consolidated. Dikes were repaired, and a channel 100 feet wide and 15 feet deep at low water was obtained through the Cow Point Shoal and the shoal below Hoquiam. This work was commenced under contracts in 1903 and completed in 1905, as far as funds would permit. The total amount expended on the inner harbor and Chehalis River, under the above projects, was $113,134.38 for improvement and $37,415.45 for maintenance of dikes and snagging, making a total of $150,549.83. On completion of work on these projects a maximum draft of 11 feet at mean lower low water could be carried to Cosmopolis and 5½ feet to Montesano. Above Montesano the river had been kept free from snags and jams.

5. PUGET SOUND AND ITS TRIBUTARY WATERS, WASH.

The original project, adopted by act of Congress of August 2, 1882, had the title "Improvement of Skagit, Stilaguamish, Nooksack, Snohomish, and Snoqualmie Rivers, Wash." Under date of August 4, 1892, the change to the new title was approved and all money and property on hand were transferred and thereafter accounted for under the new title. The original project contemplated clearing and maintaining the navigable portions of the streams named free from snags, débris, and drift. This work was accomplished by means of a shallow-draft, stern-wheel snag boat constructed for this purpose. Under this project, to June 30, 1892, $67,495.58 was expended for maintenance.

8. WATERWAY CONNECTING PUGET SOUND WITH LAKES UNION AND WASHINGTON, WASH.

The original project for this work was adopted by the river and harbor act of August 18, 1894, and provided:

> For dredging Salmon Bay and the improvement of the waterway connecting the waters of Puget Sound, at Salmon Bay, with Lakes Union and Washington by enlarging the said waterway into a ship canal, with the necessary locks and appliances in connection therewith, $25,000: *Provided*, That no part of said amount shall be expended on the improvement of the waterway connecting the waters of Puget Sound with Lakes Union and Washington until the entire right of way and a release from all liability to adjacent property owners have been secured to the United States free of cost and to the satisfaction of the Secretary of War.

On March 1, 1898, a board of Engineer officers was appointed to consider and report on the most feasible route for the waterway. The report of the board was submitted March 23, 1898, and recommended that the waterway enter Puget Sound through Shilshole Bay, and that the outer lock be located at the foot of Salmon Bay. The recommendations of the board were approved and this route was adopted by the Secretary of War on April 14, 1898.

The act of March 2, 1895, required the preparation of a map showing each piece of property required to be deeded to the United States

Digitized by Google

or from which a release was required. This map was prepared, and on June 22, 1900, the right of way was accepted by the Secretary of War from King County, Wash., as satisfactory to the United States.

The original project was modified by the river and harbor act of June 13, 1902, which provided as follows:

Improving waterway connecting Puget Sound with Lakes Union and Washington, Wash.: Continuing improvement, $160,000: *Provided*, That this appropriation, together with the unexpended balance to the credit of said improvement, shall be expended in securing, by dredging, a low-water channel 10 feet in depth from Shilshole Bay through Salmon Bay to the wharves at Ballard: *Provided further*, That a board of Engineers shall be appointed by the Secretary of War, who shall make such surveys, examinations, and investigations as may be required to determine the feasibility and advisability of constructing a canal, with necessary locks and dams, connecting Puget Sound with Lakes Union and Washington, of sufficient width and depth to accommodate the largest commercial and naval vessels, and said board shall prepare and report plans and estimates of the cost thereof. Said board shall also examine the route for a similar canal connecting Elliott Bay with Lakes Washington and Union, with a view to determine the feasibility of such route, and shall invite proposals from the Seattle & Lake Washington Waterway Co. for the construction of a similar canal over said route connecting Elliott Bay with Lake Washington, and similar proposals for connecting Elliott Bay with Lake Union through Lake Washington, said proposals to specify the time for the completion of each project, and all rights and privileges to be reserved by said company. Said board shall also report upon the relative advantages of all proposed routes. Nothing herein shall be construed as the adoption of any project for the construction of a waterway connecting Puget Sound with Lakes Union and Washington. Said board shall make its reports as above provided for to the next session of Congress.

The report of the board was adverse to the construction of a canal of the dimensions proposed.

With funds provided by the river and harbor acts of August 18, 1894, and June 3, 1896, excavation of the canal was commenced in 1901. By the removal of 1,063,251 cubic yards of material there was obtained a channel 75 feet wide and 16 feet deep at extreme low water from deep water in Shilshole Bay to the lower lock site, a distance of 6,000 feet; thence 4,000 feet a channel 75 feet wide and 10 feet deep at extreme low water to the city wharf at Ballard, with a turning basin varying from 175 to 500 feet at the inner end; and thence a cut 10 feet wide on the bottom, with its bottom 6 feet above extreme low tide, from the head of Salmon Bay to Lake Union, a distance of about 4,500 feet. Regulating gates were installed at the outlet of Lake Union and at the Portage (between Lake Union and Lake Washington). The Portage cut, excavated by private capital in 1886, was enlarged, and at the latter point two 30-inch siphons were installed to regulate the flow from Lake Washington.

In 1906 a movement was started for the construction of a canal with local funds, and an act of Congress approved June 11, 1906, authorized James A. Moore or his assigns to construct a canal, with locks, along the Government right of way. This act was modified by the act of March 2, 1907, so as to permit Mr. Moore or his assigns to commute the work required under the previous act to excavation alone of a canal from deep water in Puget Sound to deep water in Lake Washington. The same act directed a survey and estimate of cost of a single lock and a report as to what contribution, if any, local interests would make toward its construction.

By an act of the Legislature of the State of Washington approved March 16, 1907, a new right of way 500 feet wide through the State

Digitized by Google

lands lying between Lakes Union and Washington was granted to the United States.

Under an act of its legislature approved March 17, 1909, the State of Washington created a shore-land improvement fund and appropriated out of said fund the sum of $250,000, to be expended under the supervision of the district engineer officer, toward the construction of the Lake Washington Canal. With funds provided by this act and disbursed by the district officer, excavation of 161,917 cubic yards of material resulted in a cut between Lakes Union and Washington 2,000 feet long, from 0 to 50 feet deep, 75 to 80 feet wide on the bottom, side slopes 1 horizontal on 4 vertical, and with bottom sloping from 40 Engineer datum at Lake Washington end to plus 25 Engineer datum on Lake Union end. Zero Engineer datum is extreme low tide, Puget Sound, at Ballard, Wash.

The rights granted to James A. Moore by the act of June 11, 1906, modified by the act of March 2, 1907, were transferred by him to the Lake Washington Canal Association, a corporation created for the purpose of taking over Mr. Moore's rights and cooperating with the assessment district in carrying out the work proposed to be done by local agencies. This association in turn transferred the rights to King County, Wash.

9. SNOHOMISH RIVER, WASH.

The original project for this improvement was made under the title of Everett Harbor, Wash., and was adopted by the river and harbor act of August 18, 1894. The plan of improvement published in the Annual Report of the Chief of Engineers for 1893, pages 3464 to 3467, and Senate Executive Document No. 139, part 2, Fifty-third Congress, second session, provided for a harbor basin in front of the Everett Peninsula 200 feet wide, 5,300 feet long, and 26 feet deep at mean lower low water, and a navigable and inlet channel 100 feet wide and 6 feet deep at mean lower low water from the end of the basin around the peninsula to the head of Old River, the material excavated in making the basin and channel to be deposited behind a dike or bulkhead of piles and brush, built from the lower end of Smiths Island to the south end of the basin and upon high land and behind existing dikes along the other portion of the channel and Old River. The estimated cost of the work was $372,000.

By the river and harbor act of March 3, 1899, the estimated cost of the improvements was increased to $422,000.

By authority of joint resolution of Congress approved April 23, 1902, the work in Old River was discontinued, and the further expenditure of funds has been for deepening and widening the harbor basin and channel through the tide flats and repairing the bulkheads.

The amount expended on this project to June 30, 1910, was $417,577.77, of which $2,867.73 was for maintenance and $3,000.90 for purchase of quarry at Goat Island.

A dike for the purpose of retaining the dredged material has been built from the lower end of Smiths Island along the established bulkhead line for a distance of 19,336 feet. At the southern end of this work an outside bulkhead 200 feet from the other has been built for a distance of 2,600 feet. These dikes were repaired, raised, and strengthened. The channel leading north from the basin was dredged

Digitized by Google

to a depth of 6 feet at low water for a distance of 6,000 feet. A channel in the Old River was partly dredged for a distance of 11,600 feet downstream before this part of the work was discontinued under the resolution of Congress above referred to. The harbor basin was dredged for a length of 5,500 feet and for a width of 400 feet and a depth of 26 feet at mean low water. This basin has almost completely filled up. In the upper portion it was necessary to dredge the channel over 1,000 feet in length in order to obtain a depth of 8 feet at mean lower low water.

10. SKAGIT RIVER, WASH.

The Skagit River has been improved to the extent of removing snags and similar obstructions to navigation since 1882 under appropriations for the operation of a snag boat on Puget Sound and its tributary waters.

12. BELLINGHAM HARBOR, WASH.

The original project adopted by Congress by the river and harbor act of June 13, 1902, contemplated dredging Whatcom Creek waterway to a depth of 12 feet at mean lower low water and 200 feet wide from deep water as far as the railroad bridge, a distance of 1,200 feet, and to its full width (363.2 feet) inside this bridge, a farther distance of 1,950 feet. The estimated cost was $80,000.

The river and harbor act of June 13, 1902, provided—

> That no part of this appropriation ($25,000) shall be expended until provision shall have been made, satisfactory to the Secretary of War, to prevent the deposit in the channel to be improved of sawdust and refuse from the mills.

The above requirement having been complied with the Secretary of War authorized the expenditure of the appropriation for the execution of the work on June 9, 1903. Work was done under two separate contracts and was completed on April 22, 1906.

A channel 200 feet wide and 12 feet deep at low water, with turning basin at inner end, was dredged under contract. The channel extends the full length of the waterway, and the basin at the inner end is 330 feet wide and 2,570 feet long.

The work contemplated by this project was completed at somewhat less than the estimated cost, and a larger amount of dredging was done than was expected with the funds available. The amount expended on this project was $57,673.98.

14. COLUMBIA RIVER BETWEEN WENATCHEE AND BRIDGEPORT, WASH.

The project adopted by the river and harbor act approved August 18, 1894, for the improvement of the Columbia River from Rock Island Rapids to Foster Creek Rapids, Wash., included the part of the river between Wenatchee and Bridgeport. This project contemplated the removal of obstructive rocks, bowlders, and reefs, and the placing of deadmen, snubbing posts, and lines for lining over difficult and swift reaches. By the expenditure of $8,005.20 obstructive rocks were removed at Rocky Reach and Methow Rapids, and an anchoring boom with snubbing posts and deadmen with lines were placed at Entiat Rapids.

Digitized by Google

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE PORTO RICO DISTRICT.

SPANISH PROJECT FOR SAN JUAN HARBOR, PORTO RICO.

The original condition of this harbor and the artificial changes effected may best be understood by a reference to the accompanying outline maps.

Fig. 1 shows the conditions as they existed in 1883 before any work was done by the Spanish port authorities.

Fig. 2 shows the areas dredged by the Spanish port authorities during the period 1887 to 1894.

Fig. 3 shows the conditions in 1902 before work was begun by the United States.

The city of San Juan is located on a coral island of the same name. The harbor of San Juan lies back of this island. For several miles eastward of San Juan Island the sea frontage of Porto Rico consists of low sand dunes between which and the high upland are a series of lagoons and swamps which drain into San Juan Bay.

The main channel of entrance to San Juan Harbor lies close to the western shore of San Juan Island from the sea to the salient of La Puntilla, where the harbor proper is assumed to begin. La Puntilla was originally a mangrove swamp, such as surrounds the greater part of the harbor, and was reclaimed with material dredged from the entrance channel and from the harbor. The ocean swell along San Juan Island from Morro Point to La Puntilla prevents the use of this shore for shipping purposes. The developed water front lies along the protected south shore of San Juan Island eastward from La Puntilla.

From the best available information the entrance channel in 1883 had a least depth of 26 feet and a least width of about 300 feet. Inside the harbor there was a considerable area available for vessels drawing 23 feet or less.

An improvement of the harbor was commenced in 1889, and between that date and the American occupation in 1898 a total of about $647,000 was expended for dredging and for bulkheading and reclaiming adjacent swamp lands. The proceeds from the sale of reclaimed lands was utilized in making further improvements. Under these expenditures about 800,000 cubic yards were removed from the entrance channel, from the edge of La Puntilla, from Punta Larga and Yufri Shoals, and from immediately in front of the bulkheads. As a result of this work there existed in 1898 an entrance channel with a least depth of 25 feet over a least width of 400 feet. The harbor area available to vessels drawing 24 feet or less had been increased to 56 acres, and berths along the bulkheads had been deepened to receive vessels drawing 18 feet.

From 1898 until the existing project was adopted in 1907 no further work of harbor improvement was done in San Juan Harbor, except the erection by the New York & Porto Rico Steamship Co. of a pier which contributed a much needed facility for transferring freight and passengers without lightering.

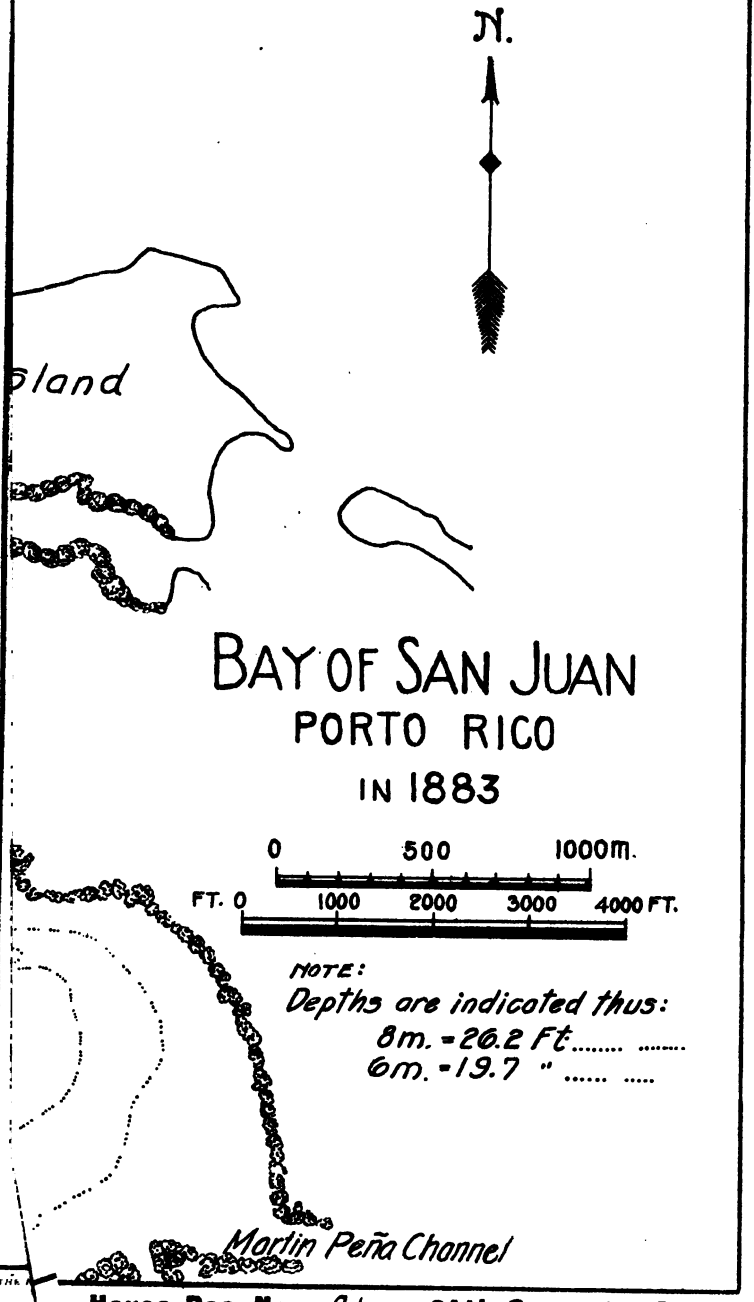
A channel exists at the eastern end of the island connecting the sea with San Antonio Channel and the harbor proper. Owing to the

Digitized by Google

influence of the prevailing easterly winds, the elevation of the sea level at this second inlet is sufficient to establish and maintain at practically all stages of tide through it and San Antonio Channel a gentle current which sweeps along the main harbor front and tends to improve the sanitary condition of this part of the harbor. Its influence upon the sanitary condition of San Antonio Channel and the harbor is its chief value. As a navigable channel it has little value, present or prospective, except for small craft. It has a depth of not over 5 feet and is obstructed by reefs, isolated rocks, and three bridges without draws, having not over 6 feet vertical clearance.

Digitized by Google

Fig. 1



House Doc. No. 91 ; 64th Cong., 1st Sess.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

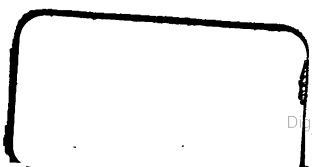
Digitized by Google

Digitized by Google

This book should be returned to the Library on or before the last date stamped below.

A fine of five cents a day is incurred by retaining it beyond the specified time.

Please return promptly.



Digitized by Google

Eng 1019.15.11
A historical summary giving the sco
Cabot Science
007066105
3 2044 091 860 288

Digitized by Google